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0. Summary

This task aims for an overview of the brain research activities funded in the EU framework programme (FP7/H2020) and the funding initiatives of JPND, NEURON and HBP.

The mapping was performed through the searching of relevant projects in the existing repositories made available by the European Commission (i.e., eCORDIS), JPND, NEURON and HBP. No brain research projects funded through national programmes in European countries were included because such analysis did not fall into EBRA's scope. A list of 21 brain research topics has been created and 1 or more topics were then assigned to each project.

In total, 3874 brain research projects received funding between 2007 and 2019. From the eCORDIS, 1990 EC-FP7 projects and 1561 EC-H2020 projects were identified. The other brain research initiatives included 124 (ERA-NET-NEURON), 90 (ERA-NET-JPND) and 109 (HBP) projects. Most brain research projects were performed in Germany, UK, France, the Netherlands, and Italy. The most popular brain research topics were Cognition and Behaviour, Animal Models, Neural Function and Neuroimaging, and the most frequently investigated brain disorders were Alzheimer Disease, Parkinson Disease and Stroke.

The results of the mapping exercise provide a European brain research landscape which will underpin the development of a Shared European Brain Research Agenda.

1. Background and Purpose

The European Brain Research Area project — EBRA — was created as a catalysing initiative for brain research stakeholders (i.e., researchers, clinicians, patients, governments, funders, and public institutions) to streamline and better co-ordinate brain research across Europe while fostering global initiatives. The Consortium consists of the European Brain Council (EBC) membership, the Network of European funding for Neuroscience research (NEURON), Joint Programme – Neurodegenerative Disease Research (JPND) and the Human Brain Project (HBP). EBRA's goals are to:

- Facilitate efficient collaboration, communication, and operational synergies, including transparent procedures and setting up of governance mechanisms
- Foster alignment and better co-ordination of research strategies across European and global brain initiatives
- Facilitate the emergence of research projects in specific areas in active clusters, and provide them with support for effective collaboration, including enabling sharing of data and access to research infrastructures
- Increase the visibility of the brain research portfolio as a whole and promote the uptake of EBRA results to key stakeholders.

Reaching these aims will ensure a better exploitation of the large investments made in brain research, will achieve critical mass and economies of scale by initiating and fostering new global research initiatives, as well enabling and accelerating the translation of breakthroughs in brain research into relevant clinical applications.

Therefore, a Shared European Brain Research Agenda (SEBRA) will be established. SEBRA will be used to provide recommendations to the European Commission on future brain research areas for excellent, innovative and translational research comprising those for maximized cooperation, reduced overlap, and fragmentation. However, to underpin the development of SEBRA and pinpoint appropriate policy actions and recommendations, an overview of the scale and scope of existing brain research activities in Europe was conducted.

The primary aim of this mapping exercise was to provide an overview the current state of brain research in Europe. Which brain research areas are the focus in Europe? The second aim of the mapping exercise was to analyse this brain research portfolio in such a way that solid conclusions on the gaps, priorities and innovation in brain research could be drawn. This information can then be used as an input for the development of SEBRA.

2. Methodology

The brain research mapping methodology was designed by EBRA's project steering committee and consists of 4 steps (see Figure 1):

1. Collection of EU brain research projects to create a database.
2. Project validation.
3. Project classification into relevant brain research categories.
4. Analysis of relevant parameters.

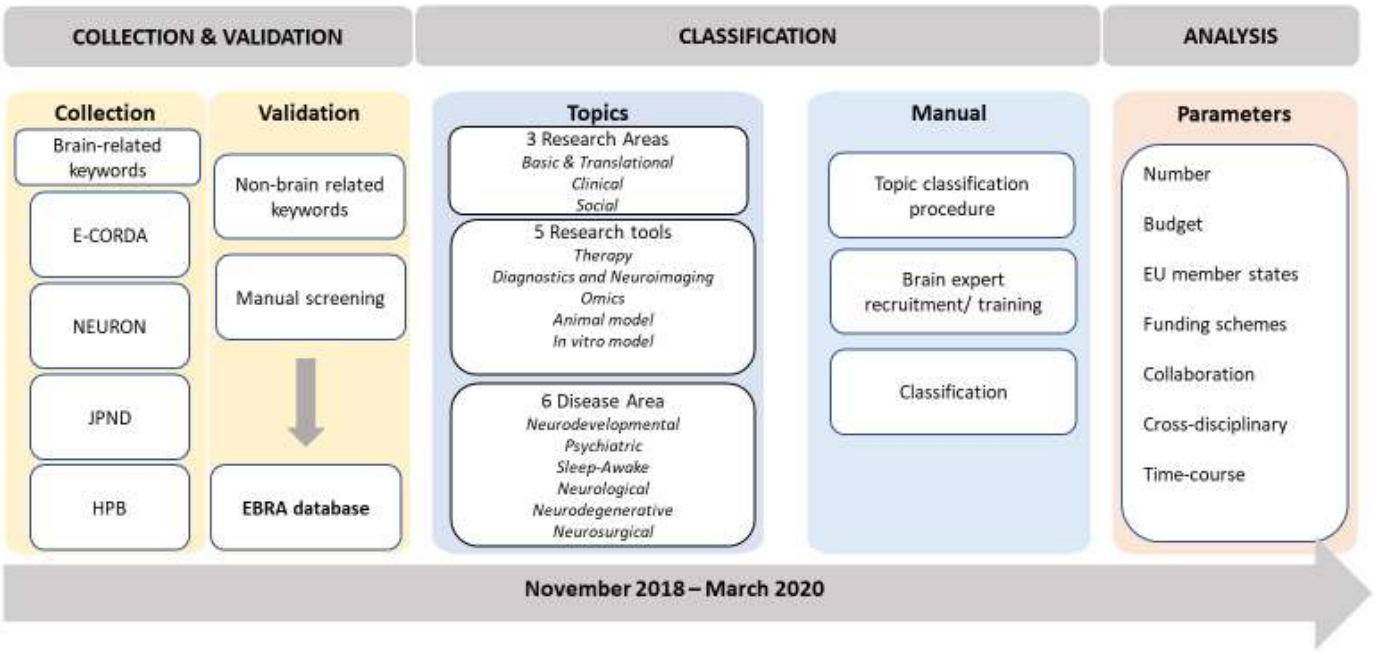


Figure 1. Brain research mapping procedure

Here below, each step will be explained in more detail.

2.1. Project collection

Research projects starting between September 2007 and September 2019 were collected from:

1. The Community Research and Development Information Service (E-CORDA) database[1]: The E-CORDA database contains the results from the projects funded by the EU framework programmes for research and innovation. Projects covered in this report were selected under FP7 and Horizon 2020 programmes. Note that the HBP is partly funded by FP7 and H2020 but is treated as a separate funding scheme in this report. This means that the number of HBP projects and related funding are not included in the FP7 and H2020 projects.
2. The EU Joint Programme – Neurodegenerative Disease Research (JPND)[2]: JPND is the largest global research initiative and supports projects aimed at tackling the challenge of neurodegenerative diseases. JPND projects covered in this report have been selected under calls JPND2011, JPND2012-Healthcare, JPND2012 - Risk factors, JPND2013 – Cross Disease, JPND2013 – Preventive Strategies, JPND2014, JPND2015, JPND2016, JPND2017 and JPND2018.
3. The European Research Area Network (ERA-NET) NEURON (Network of European Funding for Neuroscience Research)[3]: NEURON is focused on disorders of the brain (neurological, psychiatric, sensory organ) and the nervous system. It holds a strategic position among the neuroscience research community, relevant funding organizations, patient organizations, and political actors. NEURON funds translational research projects by converging preclinical and clinical research communities. More specifically, the ERA-NET NEURON funds basic, clinical and translational research in the diverse fields of neurological, psychiatric, and sensory organ diseases. NEURON projects covered in this report have been selected under calls JTC2008 - neurodegeneration, JTC2009 - new technologies, JTC2010 - mental disorders, JTC2011 – Stroke, JTC2012 –

[1] https://e-Corda.europa.eu/
[2] https://www.neurodegenerationresearch.eu/
[3] https://www.neuron-eranet.eu/

new methods, JTC2013 – mental disorders, JTC2014 – neuroinflammation, JTC2015 – ELSA, JTC2015 – Neurodevelopmental disorders, JTC2016, JTC2017 and JTC2017-ELSA.

4. The Future and Emerging Technology (FET) project, Human Brain Project (HBP)[4]: HBP is a project consisting of partnering projects, co-designed projects and work packages and is focused on building a research infrastructure to help advance neuroscience, medicine, and computing. In this report, HBP partnering projects, co designed projects and work packages are referred to as "projects" because one of the aims of the mapping report is to map the brain research topics covered by the HBP project.

JPND, NEURON and HBP projects are all brain-related and were thus automatically included in the database. By contrast, the E-Corda database contains a wide variety of projects and only a subset is brain-related. Therefore, we used a list of brain-related key words (see Table 1) to select FP7 and H2020 project abstracts from the E-Corda database. Only abstracts containing one or more brain-related keywords were included in the database. **3681** EC-FP7 and **3272** EC-H2020 projects have been detected in the E-CORDA database using this brain-related keywords approach. This first keyword selection procedure ensured that projects with no link to the brain were excluded from the database. This list was developed together with the European Commission (EC) and the Federation of European Neuroscience Societies (FENS).

Table 1. List of keywords used to identify EU brain research project abstracts

ADDIC	BIPOLAR DISORDER	DEMENT	INSOMNIA	PAIN	SCHIZO
ADHD	BRAIN	DEMYELIN	MENTAL	PARKIN	SEIZURE
ALZHEI	CEREBELL	DEPRESS	MIGRAIN	PHOBI	SENSORY
ANOREXI	CEREBR	ENCEPHA	MULTIPLE SCLEROSIS	PRION	SPINAL
ANXI	COGN	EPILEP	NERV	PSYCHIATR	STROKE
ATAXI	COMA	GLIA	NERVOUS	PSYCHOS	SUICI
AUTIS	CORTEX	HUNTINGTON	NEUR	RESTLESS LEGS SYNDROME	SYNAP

The following project information was included in the database: Call ID, Acronym, Title, Abstract, Funding Scheme, Start and End Date, Partners (Role, Country) and Funding Contribution[5].

2.2. Project screening and validation

To ensure that all included FP7 and H2020 projects were brain research projects, and that other projects were detected and excluded from the database, the selected projects went through a process of validation:

1. **Keyword approach**: Common non-brain related keywords were identified: CANCER, CARDIOVASCULAR, CLIMATE, COMMERCIAL, DIABET, ECOLOGIC, HORMONE, MARKET, POLITIC, PUBLIC, SENSO, TEMPERATURE. These keywords were selected by randomly screening a subset of abstracts. Abstracts containing one or more of these non-brain keywords were then manually screened and either included (when they were considered a brain research project) or excluded (when they were considered a non-brain research project) from the database.
2. **Manual approach**: to ensure that the database only included brain-related abstracts, we also screened all remaining abstracts, and excluded the remaining non-brain research projects.

[4] https://www.humanbrainproject.eu/

[5] Note that for some projects, not all information was available. For example, some project starting dates were missing and funding contribution was not available for individual HBP projects.

Using this approach, **1691** EC-FP7 out of 3681 and **1711** EC-H2020 out of 3272 projects were excluded from the database. This approach ensures thus that only brain research projects, and no other project were eventually included in the database.

2.3. Project classification

Each brain research project was then classified into one or more brain research categories.

2.3.1. Brain research categories

Based on the existing FENS classification[6] as well as expert consultation, a list of brain-related categories/topics was created.

Three main categories were defined:

- Research area
- Disease area
- Research tools

Each of these main categories contained some underlying categories (see Table 2).

Table 2. List of brain-related categories/topics

Research Area	Disease Area	Research Tools
BASIC AND TRANSLATIONAL RESEARCH	NEURODEVELOPMENTAL	THERAPY
NEURAL FUNCTION	PSYCHIATRIC	DIAGNOSTICS/NEUROIMAGING
NEURONAL DEVELOPMENT	SLEEP-AWAKE	OMICS
SENSORY & MOTOR SYSTEM	NEUROLOGICAL	ANIMAL MODEL
COGNITION & BEHAVIOUR	NEURODEGENERATIVE	IN VITRO MODEL
COMPUTATIONAL NEUROSCIENCE/ ROBOTICS	NEUROSURGICAL	
DISEASE AETIOLOGY		
NEUROINFLAMMATION		
CLINICAL RESEARCH		
SOCIAL RESEARCH		
HEALTH & SOCIAL CARE		
PUBLIC PATIENT ENGAGEMENT		

[6] https://forum2020.fens.org/list-of-themes/

The disease categories were further divided into their specific diseases (see Table 3).

Table 3. List of Disease Areas

Neurodevelopmental	Psychiatric	Neurological	Neurodegenerative	Neurosurgical
Autism spectrum	Schizophrenia	Epilepsy	Dementia	Spinal Cord Injury
Intellectual disability	Affective	Stroke	Parkinson	Traumatic Brain Injury
Motor disorders	Anxiety/fear	Peripheral nerve	Prion	NeuroOncology
ADHD	Addiction	Multiple sclerosis	Motor neuron	Other
Other	Other	Headache	Huntington's	
			Spinocerebellar ataxia (SCA)	
		Other	Spinal muscular atrophy (SMA)	
			Other	

2.3.2. Classification procedure

We classified the brain research projects using EBRA's brain research topic classification manual (see Annex I).

This manual contained the following information:

1. An introduction to the EBRA project
2. More information about the mapping exercise.
3. An overview of the brain research topics
4. The topic definitions and keywords, as well as additional information
5. The topic classification procedure and steps to follow.
6. Tips and Tricks and examples.

And we followed a specific classification procedure:

1. Read thoroughly the classification topic manual.
2. Read the EU brain project abstract.
3. Focus on the aim and methodology of the project, and less on the introduction, conclusions and potential impact.
4. Detect the relevant topics in the abstract and assign them to the project. Note that more than 1 topic, up to 21 (i.e., all topics) could be assigned to a project.

For example, topics assigned to the project abstract below are: Clinical Research, Health & Social Care, Alzheimer Disease and Therapy.

In Alzheimer's disease (AD), accurately forecasting disease progression and its long-term consequences is fundamental for care planning and resource allocation both at the individual and societal (macro) level. ADDITION aims to answer the following research questions: 1) what are the disease trajectories, care pathways and time to key events for an individual with AD, and which factors influence these developments? 2) What is the cost-effectiveness, economic and societal impact of interventions aimed at improving care outcomes (today) and changing the course of disease (tomorrow)?

ADDITION will integrate data from existing cohorts and registries from Sweden, France and the Netherlands on disease progression from preclinical AD, via MCI to AD dementia. We will jointly collect novel linked data on quality of life, autonomy and caregiver burden, taking care to use the same methodology resulting in maximally harmonized data. This database will be leveraged to identify milestones of relevance to patients and caregivers, and to predict the individual trajectories to these

events through a combination of statistical modeling and machine learning methods. In addition to health outcomes (dementia onset, death), we will focus on outcomes of key importance to patients and caregivers (autonomy, dignity, quality of life).

Subsequently, we will take the prediction model as a starting point to simulate and evaluate the cost-effectiveness of different interventions aimed at improving short- and long-term outcomes, including lifestyle modification, care strategies and future interventions aimed to alter the disease course, such as disease-modifying pharmacological treatment. If successful, results from ADDITION will contribute to strengthening patient competence in decision-making by providing accurate prognostic information across the entire disease course, and to enabling rational societal decisions on new preventive, therapeutic and care strategies for AD.

To ensure that the classification procedure was as standardized as possible, PhD students and postdoctoral researchers were also trained online for 1 hour by an EBRNA staff member. During this training session, the procedure was explained. Tips and tricks were given, and remaining questions were answered.

2.4. Data analysis

The following questions will be answered by the analysis:

1. How many brain research projects received funding between 2007 and 2019?
2. How many projects were funded by the different funding schemes between 2007 and 2019?
3. How much funding did each EU-member state receive for brain research?
4. What were the most/least examined brain research topics?
5. Which brain research topics received more/less funding?
6. How did the number of projects and the related budget change between 2007 and 2019 for each brain research topic?

To answer these questions, the following parameters were analysed:

- Number of projects
- Number of topics
- Budget

And the following information was considered:

- Funding scheme: EC-FP7, EC-H2020, JPND, NEURON, HBP[7].
- Project starting year: 2007-2019
- Countries: Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Republic of Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (SI), Spain (ES), Sweden (SE) and United Kingdom (UK); Non-EU member states; Global.
- Brain research topics (see Table 2 and 3).

[7] Note that the HBP is partly funded by FP7 and H2020 but is treated as a separate funding scheme in this report. This means that the number of HBP projects and related funding are not included in the FP7 and H2020 projects.

3. Results

3.1. How many brain research projects received funding between 2007 and 2019?

In total, 3874 brain research projects received funding between 2007 and 2019 (see Table 4) [8].

Table 4. Brain research projects starting between 2007 and 2019

Starting Year[9]	Number	Budget (K€)*
2007	9	910
2008	185	381 820
2009	223	295 905
2010	270	463 177
2011	316	412 381
2012	332	496 219
2013	359	726 626
2014	338	394 934
2015	353	510 443
2016	416	742 297
2017	376	507 833
2018	465	618 539
2019	93[10]	140 834
Total	**3874**	**5 881 523**

* Note that the HBP budget was not included. HBP is a single project which consequently did not allow to extract the budget per project and per year. HBP is funded by four specific grants lasting between 2 to 3 years. See Table 5 and Annex II for total HBP budget information.

[8] Not all information on the budget and number of projects for recent years was available at the time-point of the report.

[9] Note that the official project starting dates/years could differ within a consortium. For example, one participant might start the project in 2015 while the other starts in 2016. To be consistent, we always refer to starting year as the earliest year that one of the project participants or the coordinator started the project.

[10] The number of projects in 2019 is lower because 1. 2019 is the second last year of the H2020 programme; 2. The cut-off starting date was September 2019; 3. Not all information about projects starting in 2019 was available.

3.2. How many projects were funded by the different funding schemes between 2007 and 2019?

For each funding scheme, we evaluated the number of projects and their associated project budget over a period of 12 years (from 2007-2019; see Table 5). Most projects were funded by the European Commission (FP7 and H2020) and others by the European brain research initiatives.

Table 5. Brain research projects by funding scheme

Funding Scheme	Number of projects funded by the funding scheme	Associated project budget (k€)	% EC-contribution	% Member state or partner contribution
EC-FP7	1990	3 101 447	100%	NA
EC-H2020	1561	2 544 278	0.00%	NA
ERA-NET NEURON	124	107 373	5 %*	95%
JPND	90	128 425	5.5 %**	94.5 %
HBP	109	291 600	79.3 %***	20.7 %

* The total contribution by the EC to NEURON 2007-2017 was 9.28 Mio. € (NEURON II, GA291840; NEURON Cofund, GA680966). Of these, 5.39 Mio. € were contributed to co-fund some of the research projects (5%, see above), while 3.89 Mio. € were dedicated to other activities and management.

** The total contribution by the EC to JPND 2007-2019 was 14.04 Mio. € (JPsustaiND, JUMPAHEAD, JPcofuND). Of these, 7 Mio € were contributed to co-fund some of the research projects (5,5 %, see above), while 7.04 Mio. € were dedicated to other activities and management. Note that the JPcofuND2 was not considered here because related projects only started in 2020 which falls out of the scope of this mapping report.

*** Because the HBP is a single project and is not a collection of projects, an estimate of the total HBP budget between 2007 and 2019 was added. See ANNEX II for more details.

We also evaluated the total number of projects and budget per funding scheme over the years (see Table 6). The number of projects and related funding slightly increased over the years with peaks in 2013, 2016 and 2018.

Table 5. Brain research projects by funding scheme starting between 2007 and 2019

	Starting date (year)									
Funding scheme	**2007**		**2008**		**2009**		**2010**		**2011**	
	n	k€	n	k€	n	k€	n	k€	n	k€
FP7	9	910	185	381 819	208	282 207	264	456 731	300	398 921
H2020	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
JPND	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NEURON	NA	NA	NA	NA	15	13 699	6	6 447	16	13 460
HBP	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Funding scheme	2012		2013		2014		2015		2016	
	n	k€	n	k€	n	k€	n	k€	n	k€
FP7	322	475 835	344	712 108	291	346 318	41	42 555	NA	NA
H2020	NA	NA	NA	NA	5	348	273	421 125	393	729 087
JPND	5	15 259	3	4 028	28	37 571	20	32 204	7	6 791
NEURON	5	5 125	11	10 490	14	10 698	16	14 559	9	6 420
HBP	NA	NA	1	NA	0	0	3	NA	7	NA

Funding Scheme	2017		2018		2019	
	n	k€	n	k€	n	k€
FP7	NA	NA	NA	NA	NA	NA
H2020	353	491 664	361	600 999	91	139 891
JPND	1	50	6	8 965	0	0
NEURON	17	16 120	11	8 577	1	944
HBP	5	NA	87	NA	1	NA

3.3. How much funding did each EU-member state receive for brain research?

The five countries receiving the most funding for brain research projects are Germany, UK, France, Netherlands, and Italy. By contrast, the countries receiving the least funding for brain research are Bulgaria, Lithuania, Malta, Greece, and Slovenia (see Figure 2, Table 7, and ANNEX III for more details)[11] [12]. Note that the HBP budget has not been included in this analysis. More information about the total HBP budget between 2007 and 2019 can be found in Table 5 and Annex II.

Figure 2. Budget distribution of brain research projects in Europe.

[11] Note that for EC-FP7 and EC-H2020, only total project contributions were available. Therefore, the total project budget (instead of a part of the budget) was considered for each country within a consortium. For example, when Germany, France and Greece were involved in a 500.000 € brain research project, the amount of budget counted per country was 500.000 €.

[12] Note that for JPND and NEURON, the budget distribution is proportional to what the funders put into the call.

Table 6. Brain research projects per EU-member state[13]

Country	Number	Budget (k€)
DE	1052	959 726
UK	1176	929 210
FR	832	657 653
NL	620	474 554
IT	637	443 529
ES	618	371 450
SE	368	254 676
BE	355	208 466
AT	214	144 791
DK	214	126 290
FI	157	110 691
PT	166	84 360
HU	96	72 158
IE	135	71 032
PL	109	39 992
CZ	66	29 351
LU	45	16 977
EE	32	14 099
CY	27	11 829
RO	30	11 679
HR	12	9 660
SK	21	6 076
LT	11	3 156
BG	8	3 135
LV	5	1 583
MT	2	748
GR	3	404
SL	1	333
Non-EU	581	419 363
Global	652	404 552

[13] Country abbreviations: Austria (AT), Belgium (BE), Bulgaria (BG), Croatia (HR), Republic of Cyprus (CY), Czech Republic (CZ), Denmark (DK), Estonia (EE), Finland (FI), France (FR), Germany (DE), Greece (GR), Hungary (HU), Ireland (IE), Italy (IT), Latvia (LV), Lithuania (LT), Luxembourg (LU), Malta (MT), Netherlands (NL), Poland (PL), Portugal (PT), Romania (RO), Slovakia (SK), Slovenia (Sl), Spain (ES), Sweden (SE) and United Kingdom (UK); Non-EU member states; Global.

3.4. What were the most/least examined brain research topics?

For each topic, we evaluated the number of projects[14]. Projects focused on Cognition and Behaviour, Animal Model, Neural Function and Neuroimaging are most numerous. Less projects are focused on neurodevelopmental disorders, neuro-immunology, public/patient engagement, and other disorders of the brain (see Table 8, Figure 3 for topics). Alzheimer disease and other dementias, Parkinson's disease and PD-related diseases, Stroke and Autism spectrum disorders are the most common investigated diseases. Motor Disorders, Peripheral Nerve Diseases, Headache and Spinal Muscular Atrophy (SMA) are least examined in the projects (see Figure 4).

Table 7. Overview of the most and least examined brain research topics per category.

Research area	Research tools	Disease area	Disease
1. Cognition and Behaviour	1. Animal model	1. Neurodegenerative	1. Alzheimer
2. Neural Function	2. Neuroimaging	2. Neurological	2. Parkinson
3. Sensory and Motor Systems	3. Omics	3. Psychiatric	3. Stroke
…	4. Therapy	4. Neurodevelopmental	
	5. In vitro model	5. Neurosurgical	…
9. AI/Robotics	6. Diagnostics	6. Sleep-awake	
10. Public/Patient Engagement			22. Peripheral nerve diseases
11. Neuro-Immunology			23. Headache
			24. SMA

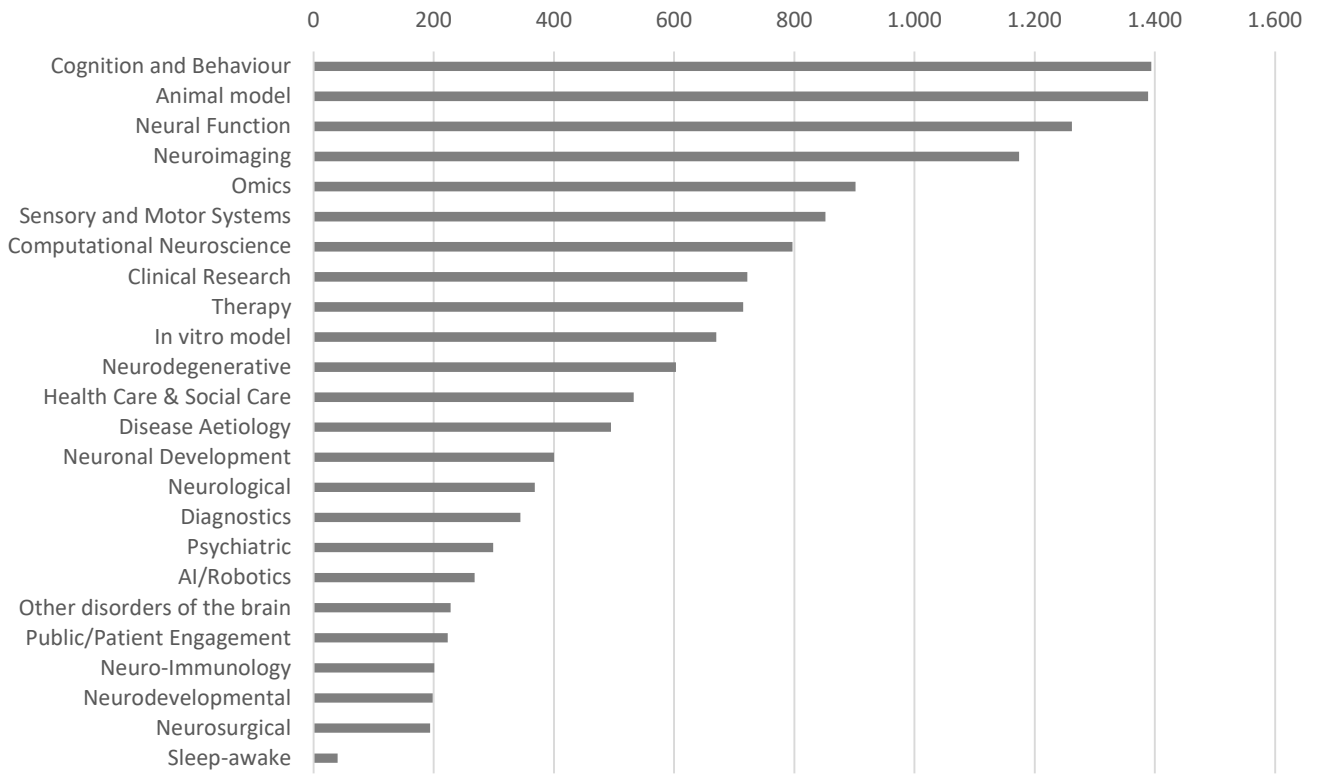


Figure 3. Number of projects per topic.

[14] More information on the topics and number of topics assigned to the brain research projects in the database can be found in ANNEX IV.

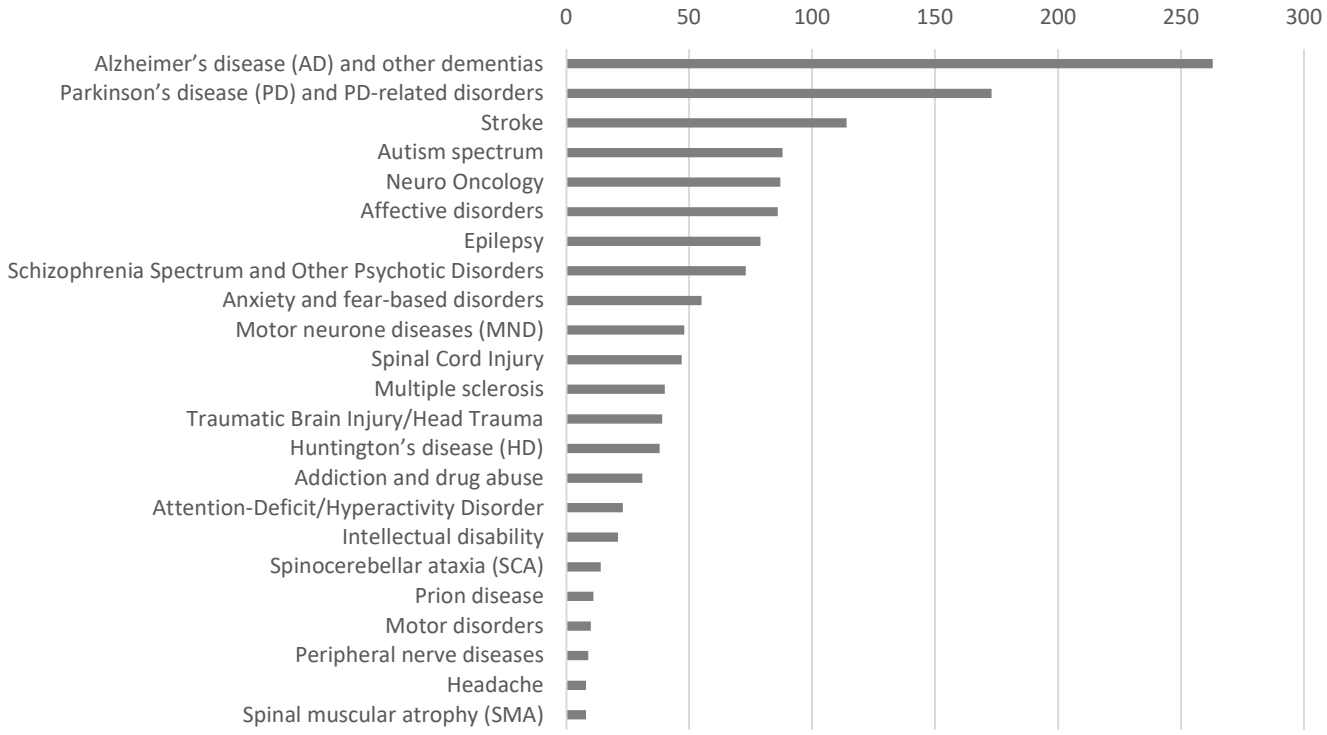


Figure 4. Number of projects per disease.

3.5. Which brain research topics received more/less funding?[15]

For each topic and subtopic, we evaluated the number of projects and their associated budget[16]. Projects focused on Animal Models, Cognition and Behaviour, Clinical Research, Therapy and Computational Neuroscience receive relatively more funding compared to projects focused on Neurodevelopmental Disorders, other disorders of the brain, Neuro-Immunology, Neurosurgical Diseases and Sleep-Awake Disorders (see Table 9, Figure 5). Regarding diseases, most budget went to projects focused on Alzheimer Disease/Dementia, Parkinson's Disease, Autism Spectrum disorders, Stroke and Affective disorders (see Table 9, Figure 6)[17][18].

Table 8. Overview of the most and least funded brain research topics per category.

Research area	Research tools	Disease area	Disease
1. Cognition and Behaviour	1. Animal model	1. Neurodegenerative	1. Alzheimer
2. Computational Neuroscience	2. Therapy	2. Neurological	2. Parkinson
3. Clinical Research	3. Neuroimaging	3. Psychiatric	3. Stroke
…	4. Omics	4. Neurodevelopmental	…
9. Public/Patient Engagement	5. Diagnostics	5. Neurosurgical	25. Peripheral nerve diseases
10. Neuronal Development	6. In vitro model	6. Sleep-awake	26. Headache
11. Neuro-Immunology			27. SMA

[15] Note that the HBP budget has not been included in this analysis. More information about the total HBP budget between 2007 and 2019 can be found in Table 5 and Annex II.
[16] The budget per topic is calculated as the sum of the project budgets associated to each topic.
[17] More information on brain research topics receiving more than 500K€/project can be found in ANNEX VI.
[18] More information on the size of the consortia per brain research topic can be found in ANNEX VII.

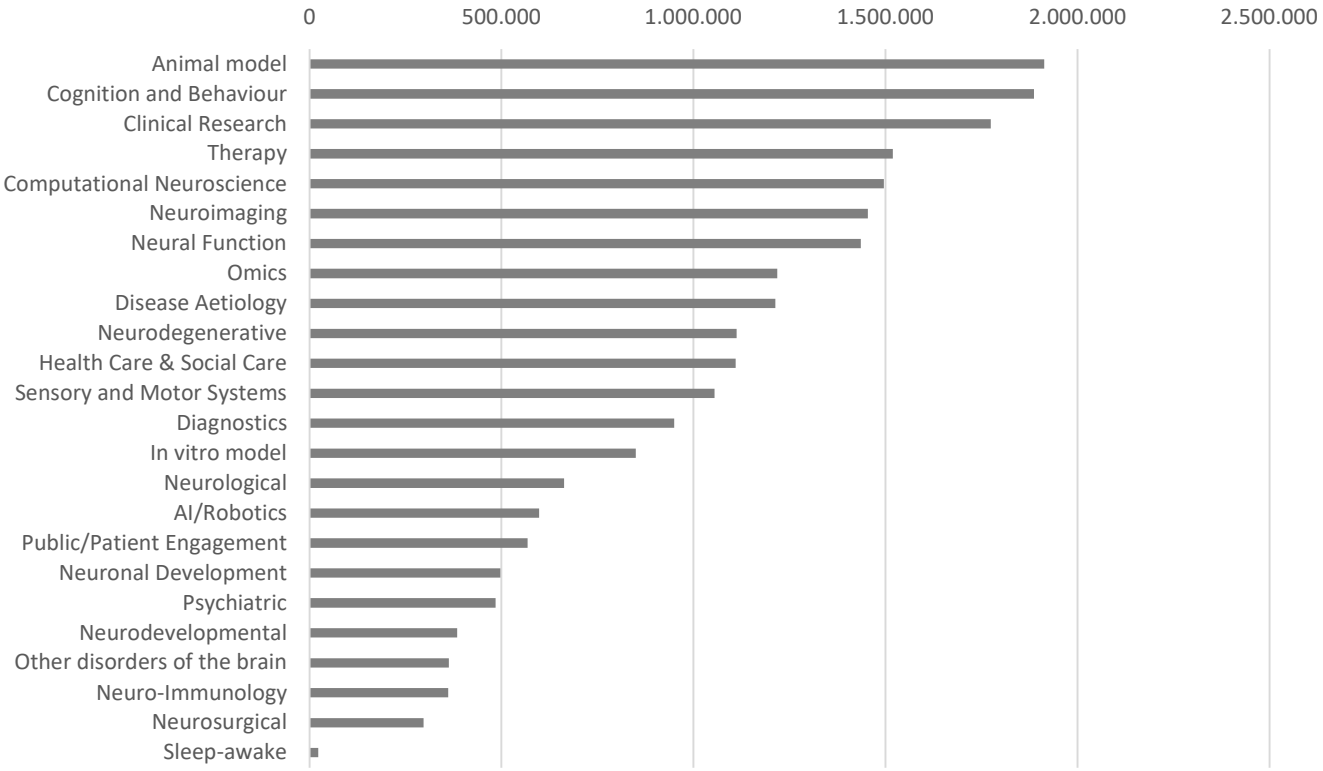


Figure 5. Budget (in k€) per topic.

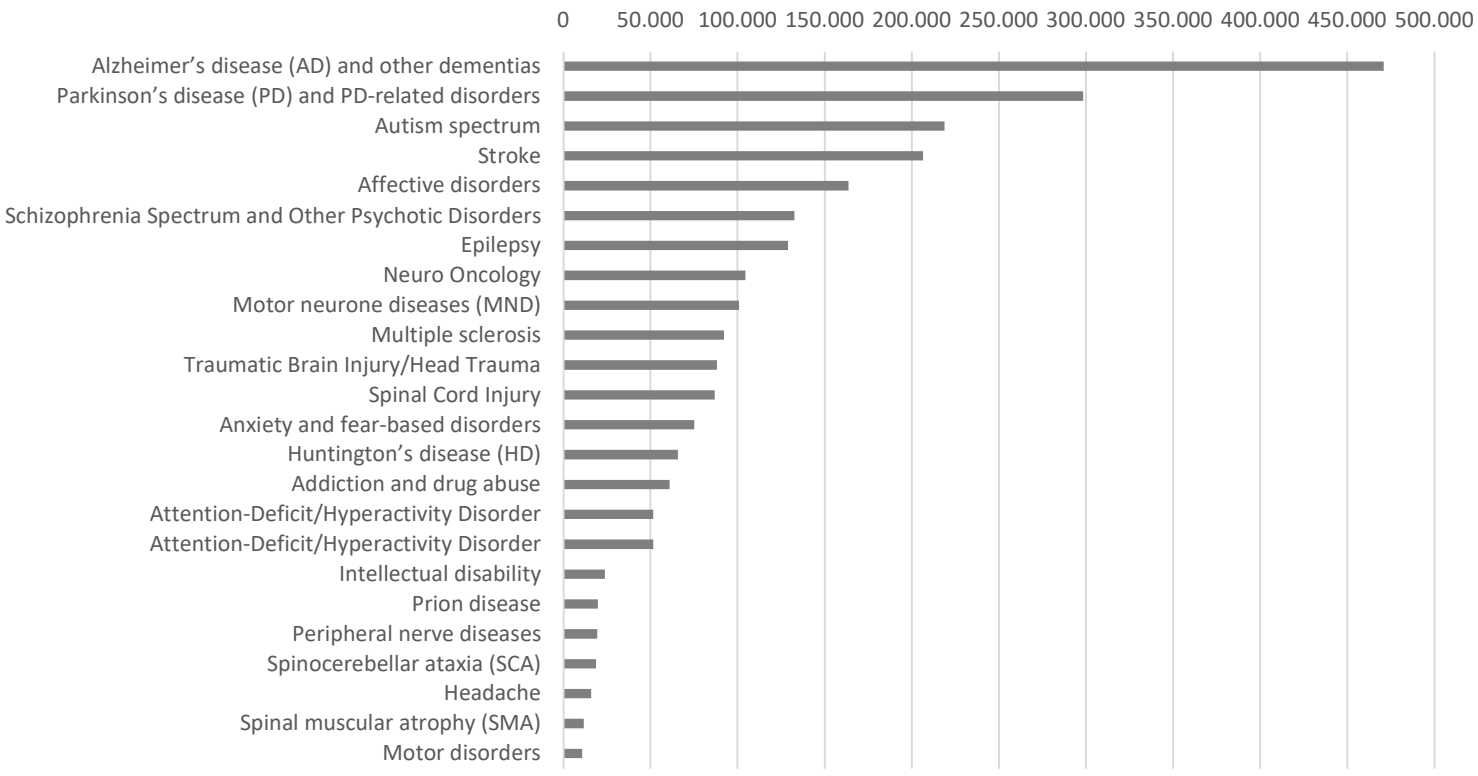


Figure 6. Budget (in k€) per disease.

3.6. How did the number of projects change between 2007 and 2019 for each brain research topic?

We also evaluated the percentage[19] [20] of projects addressing the brain research topics in the years 2008, 2013 and 2018 (see Figure 7-9; see Annex V for details on number of projects and associated budget per year and topic). Table 10 shows the brain research topics that are more addressed over time. Table 11 shows the topics that became less popular to investigate.

Table 9. Brain research topics more addressed over time (2008-2013-2018) in brain research projects.

Research area	Research tools	Disease area
Computational neuroscience	Diagnostics	Neuro-developmental[21]
Clinical Research	Neuroimaging	Neurological
Health and Social Care		
Public Patient engagement		

Table 10. Brain research topics less addressed over time (2008-2013-2018) in brain research projects.

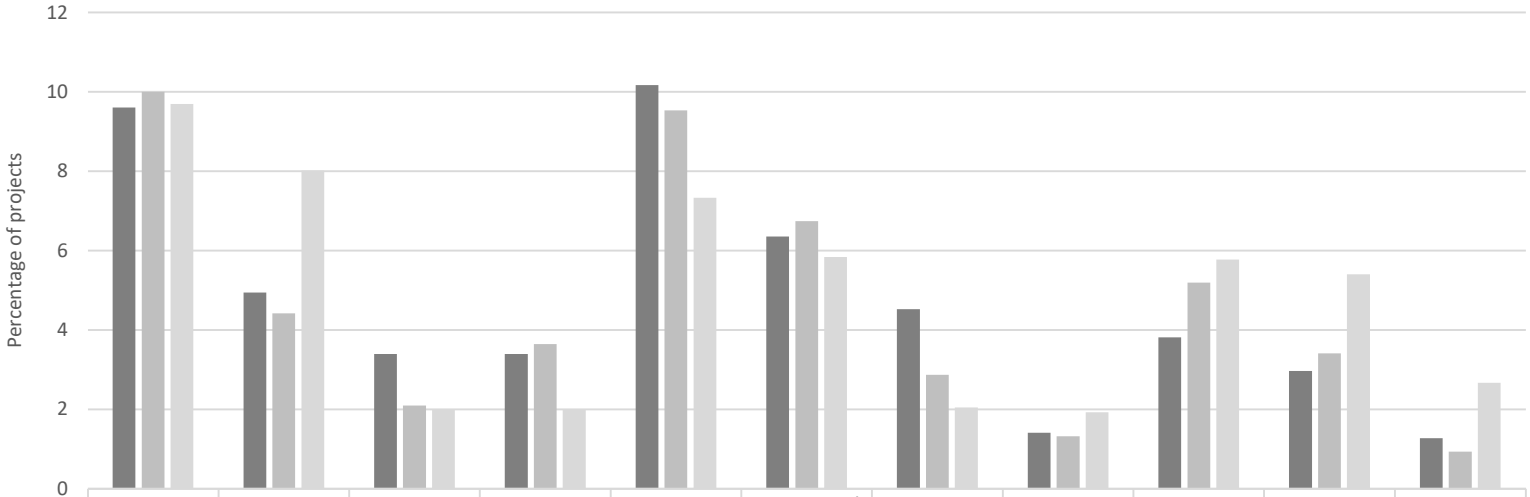
Research area	Research tools	Disease area
Neural function	Omics	Neurodegenerative
Neuronal development[22]	In-vitro model	Other
Robotics		
Disease Aetiology		

[19] Note that the percentage was calculated as the number of projects addressing a certain topic divided by the total number of research projects in the given year (2008, 2013 or 2018) multiplied by 100.

[20] No correction for budget was applied.

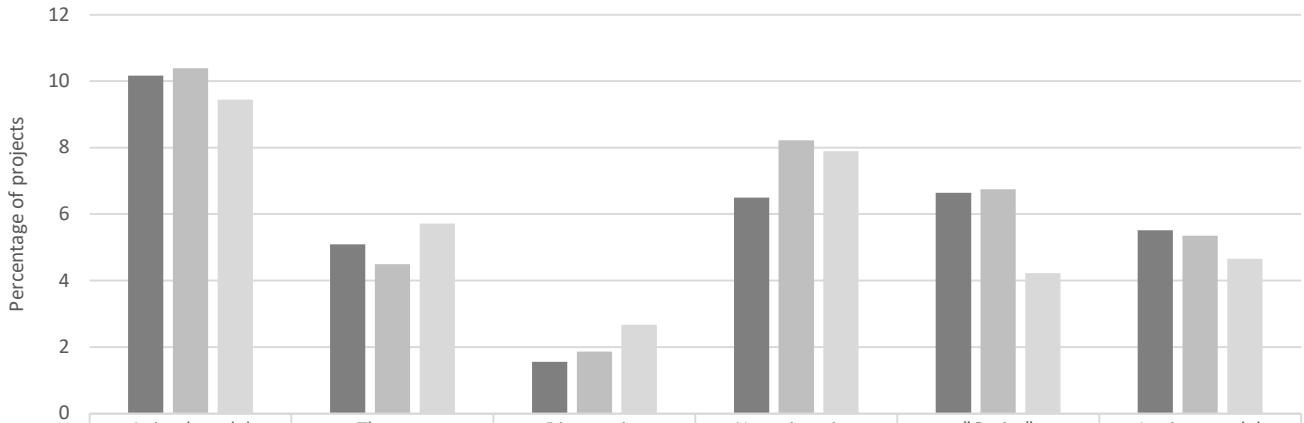
[21] Neurodevelopmental disorders refer to autism spectrum disorders, Attention Deficit Hyperactivity Disorder, Intellectual disabilities, Motor disorders and other disorders resulting from impairments of the growth and development of the brain and/or central nervous system.

[22] The research area "Neuronal development" refers to research aiming to unravel the biological process by which neurons are born, migrate and maturate during development.



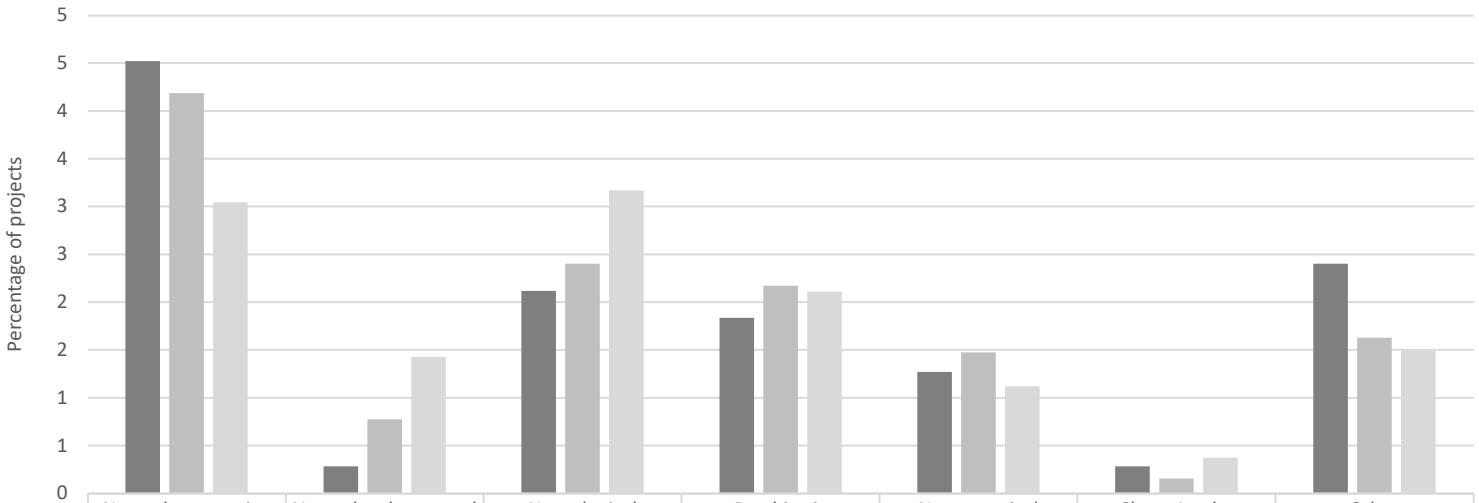
	Cognition and Behaviour	Computational Neuroscience	Robotics	Disease Aetiology	Neural Function	Sensory and Motor Systems	Neuronal Development	Neuro-Immunology	Clinical research	Health Care & Social Care	Public/Patient Engagement
2008	9,60	4,94	3,39	3,39	10,17	6,36	4,52	1,41	3,81	2,97	1,27
2013	10,00	4,42	2,09	3,64	9,53	6,74	2,87	1,32	5,19	3,41	0,93
2018	9,69	8,01	1,99	1,99	7,33	5,84	2,05	1,93	5,78	5,40	2,67

Figure 7. Percentage of projects addressing the research areas in 2008, 2013, and 2018.



	Animal model	Therapy	Diagnostics	Neuroimaging	"Omics"	In vitro model
2008	10,17	5,08	1,55	6,50	6,64	5,51
2013	10,39	4,50	1,86	8,22	6,74	5,35
2018	9,44	5,71	2,67	7,89	4,22	4,66

Figure 8. Percentage of projects addressing research tools in 2008, 2013, and 2018



	Neurodegenerative	Neurodevelopmental	Neurological	Psychiatric	Neurosurgical	Sleep-Awake	Other
2008	4,52	0,28	2,12	1,84	1,27	0,28	2,40
2013	4,19	0,78	2,40	2,17	1,47	0,16	1,63
2018	3,04	1,43	3,17	2,11	1,12	0,37	1,49

Figure 9. Percentage of projects addressing the disease areas in 2008, 2013, and 2018

4. Next steps

The aim of the present mapping exercise was to provide an overview the current state of brain research in Europe. 3874 brain research projects were identified in the eCORDIS (EC-FP7 and H2020 projects), ERA-NET-NEURON, ERA-NET-JPND and HBP databases. Most brain research projects were performed in Germany, UK, France, the Netherlands, and Italy. The most popular brain research topics were Cognition and Behaviour, Animal Models, Neural Function and Neuroimaging. The brain related diseases that were investigated mostly were Alzheimer's disease (and other dementias), Parkinson's disease, and autism spectrum disorders.

This overview of existing brain research activities in Europe will be used during the development of the Shared European Brain Research Agenda (SEBRA). Together with brain research experts, we will interpret these results and use this evidence to identify future priorities, existing gaps, and innovations in brain research. This combination of an evidence-based and expert-opinion approach will eventually lead to a list of policy actions and recommendations for the European Commission. This will streamline and better co-ordinate brain research across Europe and ensure a better exploitation of the large investments made in brain research.

TOPIC CLASSIFICATION MANUAL

Contents

0. Introduction to the EBRA project

Brain research in Europe is a rapidly evolving field, and increasingly at the forefront of science. The complexity of understanding physiological brain functions and brain diseases brings responsibilities to develop novel tools and approaches to advance our understanding of unknown basic brain functions, as well as opportunities to generate novel therapeutic approaches, thus confronting with a major societal challenge in Europe and worldwide. Considering the costs of brain diseases for the European society, and that these costs will increase considerably in the coming years due to the ageing of the European population, the EU and its Member States have made considerable investments in brain research leading to a significant increase of initiatives in this area. Although these initiatives have generated considerable amounts of knowledge and innovative approaches, the translation into new health interventions is hindered by the complexity of the challenge and by excessive fragmentation of the efforts. Effective and efficient collaboration and cooperation among the various initiatives are often identified as a key success factor to achieve brain research full impact. In particular, there is a constant need for strengthening the information flow and accelerating the exchange of experience on the on-going and future projects as well as maintaining continuous dialogue between all the stakeholder groups and initiatives to allow that objectives are aligned, and needs are met. EBRA will fully respond to these needs by bringing together the various stakeholders and major brain research initiatives, at European level and beyond, and creating the conditions for real and effective cross fertilisation, dialogue, building consensus and exploiting research potential to deliver new health interventions in brain disorders.

1. Mapping of the European Brain Research Landscape (WP 2.1.)

1.1. Scope

The scope of WP2.1. is to provide an overview of the current landscape of the European brain research funded in the EU framework programmes and the funding initiatives of JPND, NEURON, and Human Brain Project (HBP). The mapping results will help to identify gaps and opportunities and to clarify research objectives and priorities.

1.2. Procedure

In order to map the neuroscience projects funded by the EU, we first created a database including all EU brain related project abstracts. We then screened this database to identify and exclude false positive (i.e., non-brain related abstracts). This was followed by an automatic (machine learning) topics mapping which will be completed by a manual topic assignment.

1.2.1. Creation of a brain research abstracts dataset

The abstracts were selected from the Community Research and Development Information Service (E-CORDA) database (https://e-Corda.europa.eu/en) as well as from the EU Joint Programme – Neurodegenerative Disease Research (JPND; https://www.neurodegenerationresearch.eu/), the European Research Area Network (ERA-NET) NEURON (https://www.neuron-eranet.eu/index.php) and the Future and Emerging Technology (FET) project, Human Brain Mapping (HBP; https://www.humanbrainproject.eu/en/). The E-CORDA database contains the results from the projects funded by the EU's framework programmes for research and innovation (FP1 to Horizon 2020). JPND is the largest global research initiative aimed at tackling the challenge of neurodegenerative diseases. The ERA-NET NEURON supports basic, clinical and translational research in the diverse fields of disease-related neuroscience. The HBP is building a research infrastructure to help advance neuroscience, medicine and computing. The extraction of brain related abstracts from the E-Corda database was done by using a list of key words based on that we received from mister Cooper from EC who performed a similar exercise in the past. We further enriched Mr Cooper's list using additional keywords from the classification of abstracts by the Federation of European Neuroscience Societies. Finally, we test the "efficacy" of our list of keywords by extracting abstracts from JPND and ERANET neuron databases. We were able to extracts the 100 of the abstracts from these databases showing that our list is able to extract brain related abstracts. For each abstract the following information were extracted, title, abstract, funding scheme, acronym, project start and end, participating organisations and countries, and budget.

1.2.2. False positive abstract screening

In order to assure that the data extracted from the E-Corda database only included brain related abstracts, we manually screened a subset random abstract. This approach led to the identification of keywords that were yielding more false positives. These keywords were used to automatically identify potential false positive abstracts in the database. Potential false positive were evaluated and those non-related to brain research were eliminated by the dataset. This approach was completed with a manual detection and removal of non-brain related abstracts.

1.2.3. Automatic topic mapping

A machine learning algorithm extracts various topics from the abstracts and then evaluates the number of abstracts in each of the topic identified. The main idea under this algorithm is that each abstract is a mixture of topics, each topic is a distribution over words and each word is drawn from one of these topics. The extraction of the topics can be done in two manners: 1) Unsupervised and 2) Supervised. The two approaches are not mutually exclusive and are used in sequence (unsupervised can be used to generate topics and key words to input in a supervised approach).

2. Manual Topic Assignment

Following the quality check of the topic assignment by the machine learning algorithm, we noticed that the algorithm was not able to accurately assign all abstracts to the correct topic(s). Therefore, we decided to complete this machine learning approach with a manual topic assignment approach. This manual topic assignment will be performed by several experts in neuroscience. In order to guarantee a high level of inter-classifier/expert reliability, we created a classification manual of the topics where you can find a definition, description, keywords and examples of abstracts belonging to the topic, as well as a classification procedure to follow.

2.1. Table of topics

Topic Number	Basic research
1	Neural Function
2	Neuronal Development
3	Sensory and Motor Systems
4	Cognition and Behaviour
5	Computational Neuroscience/robotics
5A	*Computational Neuroscience*
5B	*Robotics*
6	Disease Aetiology
7	Clinical Research
8	Health Care & Social Care
9	Public/Patient Engagement
10	Neuro-Immunology
	Disease Area
11	Neurodevelopmental disorders
12	Psychiatric diseases
13	Sleep-Awake disorders
14	Neurological diseases
15	Neurodegenerative diseases
16	Neurosurgical diseases
	Research tools
17	Therapy
18	Diagnostics&Neuroimaging
18A	*Diagnostics*
18B	*Neuroimaging*
19	omics
20	Animal model

21	In vitro model
NBR	**Not Brain Related**
NA	**Not assigned/Don't know**

	Disease Area
11	**Neurodevelopmental disorders**
11A	*Autism spectrum disorders*
11B	*Attention-Deficit/Hyperactivity Disorder*
11C	*Intellectual disability*
11D	*Motor disorders*
11E	*Other*
12	**Psychiatric diseases**
12A	*Schizophrenia Spectrum and Other Psychotic Disorders*
12B	*Affective disorders*
12C	*Anxiety and fear-based disorders*
12D	*Addiction and drugs of abuse*
12E	*Other*
13	**Sleep-Awake disorders**
14	**Neurological diseases**
14A	*Epilepsy*
14B	*Stroke*
14C	*Peripheral nerve diseases*
14D	*Multiple sclerosis*
14E	*Headache*
14F	*Other*
15	**Neurodegenerative diseases**
15A	*Alzheimer's disease (AD) and other dementias*
15B	*Parkinson's disease (PD) and PD-related disorders*
15C	*Prion disease*
15D	*Motor neurone diseases (MND)*
15E	*Huntington's disease (HD)*
15F	*Spinocerebellar ataxia (SCA)*
15G	*Spinal muscular atrophy (SMA)*
15H	*Other*
16	**Neurosurgical diseases**
16A	*Spinal Cord Injury*
16B	*Traumatic Brain Injury/Head Trauma*
16C	*Neuro Oncology*
16D	*Other*

2.2. Topic Definitions and Keywords

1. Basic/Clinical/Social Research
1. Basic research
Aims at understanding the mechanisms, causal structure, and functioning of the brain.
Intents to increase scientific knowledge, and to find theoretical truth and understanding.
Topic 1: Neural Function:
Research aiming to understand the mechanisms and functioning of neurons
SYNAPSE, GLIA, MICROGLIA, ASTROCYTE, OLIGODENDROCYTE, INTERNEURON, MOTOR NEURON, TRANSMISSION, NEUROTRANSMITTER, NEURAL FUNCTION, RECEPTOR, FIRING RATE, GLUTAMATE, GABA, MEMBRANE, ACTION POTENTIAL, NEUROBIOLOGY, ION CHANNEL, PRESYNAPTIC, POSTSYNAPTIC, CALCIUM IMAGING
Topic 2: Neuronal development:
Research aiming to unravel the biological process by which neurons are born, migrate and maturate during development. The processes that contribute to neuronal development include proliferation, differentiation, migration, axon guidance, synapse formation, transplantation, regeneration, and remodelling.
NEUROGENESIS, SYNAPTOGENESIS, GLIOGENESESIS, PRECURSOR, PROLIFERATION, NEURONAL DEVELOPMENT
Topic 3: Sensory and Motor Systems:
Research studying both how sensory processing and motor functions interact at the neural level, and how behaviour can drive this interaction.
SENSORY, SOMATOSENSORY, OLFACTION, VISION, AUDITORY, TACTILE, VESTIBULAR, PERCEPTION, PAIN, GUSTATORY, HAIR CELL, SENSORIMOTOR, RETINA, MACULA, HEARING, PHOTORECEPTOR, INNER EAR, MOTOR, PROPRIOCEPTION, PUPIL, SOMATO SENSATION, TOUCH, CHRONIC PAIN, TASTE, ODOUR
Topic 4: Cognition and Behaviour
Studies of cognitive processes and behaviour like learning and memory, attention, language, emotion, social cognition, moral decision making. The subjects for these studies range from normal human adults and infants to brain-damaged patients, and various non-human primate and avian species. Methodologies include computer-based behavioural tests and web-based surveys to assess functional patterns in behaviour, as well as functional neuroimaging techniques (such as magnetic resonance imaging, electroencephalography, magnetoencephalography and transcranial magnetic stimulation) to study the neural bases of various components of cognition and behaviour.
COGNITION, MEMORY, LEARNING, LANGUAGE, ATTENTION, DECISION MAKING, REWARD, EMOTION, CONSCIOUSNESS, ADDICTION, DEPRESSION, BEHAVIOURAL, AVERSIVE, ANXIETY
Topic 5: Computational neuroscience/Robotics
5AComputational Neuroscience Computational neuroscience is the field of study in which mathematical tools and theories are used to investigate brain function. It can also incorporate diverse approaches from electrical engineering, computer science and physics in order to understand how the nervous system processes information. It also uses computer models to understand and rebuild neuronal networks *5BRobotics/Artificial Intelligence* Robotics is an interdisciplinary branch of engineering and science that includes mechanical engineering, electronic engineering, information engineering, computer science, and others. Robotics deals with the design, construction, operation, and use of robots, as well as computer systems for their control, sensory feedback, and information processing. AI is the study and design of intelligent agents" where an intelligent agent is a system that perceives its environment and takes actions which maximizes its chances of success.

COMPUTATIONAL PROSTHETICS, NEURONAL NETWORK, NEURAL NETWORK, MACHINE LEARNING, ARTIFICIAL INTELLIGENCE, ROBOT, COMPUTER MODEL, ALGORITHM, MATHEMATICAL, SIMULATION, PROGRAMMING, NEURAL CIRCUIT
Topic 6: Disease aetiology
Study of the determinants that are involved in the cause, risk or development of disease, conditions and ill health.
ABNORMAL, ALTERATION, DYSFUNCTION, DEFECT, CHRONICDISEASE, PATHO, SYNDROME, DEFICIENCY, DISRUPTION, IMPAIRMENT, NEUROLOGICAL_ DISEASE, MORTALITY, DECLINE, DISEASE AETIOLOGY, PSYCHIATRIC
Topic 10: Neuro-immunology
Neuroimmunology is concerned with the interactions between the nervous and the immune system. Neuroimmunologists seek to better understand the interactions of these two complex systems during development, homeostasis, and response to injuries.
IMMUNE, AUTOANTIBODY, INFLAMMA, NEURO-IMMUNOLOGY, IMMUNOLOGY, MICROBIOME, MULTIPLE SCLEROSIS, NEUROINFLAMMATION, CYTOKINES, NEUROIMMUNE
2. Topic 7: Clinical research
Clinical research is the study of health and illness in people. It is the way we learn how to prevent, diagnose and treat illness. Clinical research describes many different elements of scientific investigation. Simply put, it involves human participants and helps translate basic research (done in labs) into new treatments and information to benefit patients. Clinical trials as well as research in epidemiology, physiology and pathophysiology, health services, education, outcomes and mental health can all fall under the clinical research umbrella.
COHORT, CLINICAL TRIAL, TREATMENT, CLINICAL RESEARCH, DRUG, PROGNOSIS, RISK FACTOR, PHASE II, PHASE III, PHASE IV, TRIAL, PREVALENCE, INCIDENCE
3. Social research
Topic 8: Health and Social Care
Socials Care Research focused on investigating activities of daily living, maintaining independence, social interaction, enabling the individual to play a fuller part in society, protecting them in vulnerable situations, helping them to manage complex relationships and (in some circumstances) accessing a care home or other supported accommodation. Health Care Research focused on care related to the treatment, control or prevention of a disease, illness, injury or disability, and the care or aftercare of a person with these needs.
HEALTH CARE, POLICY, SOCIAL CARE, ECONOMY, SOCIETY, HTA, ECONOMIC BURDEN, SERVICE, GUIDELINES, HOSPITAL, IMPLEMENTATION
Topic 9: Public/Patient Engagement&Involvement
Patient and public involvement (PPI) describes how people living with medical conditions (patients) and public can become involved/engaged in research and advocacy activities. By working alongside scientists, clinicians, industry and/or regulators, the patient/public and their input can play an important role in contributing to and/or guiding the pathway to therapy development to improve the quality of life of people with brain disorders. Activities like conferences, workshops, awareness days, etc. can be organised to engage and involve the public/patient in research on braindisorders.
CITIZEN, PLATFORM, STAKEHOLDER, PATIENT, PUBLIC, ENGAGEMENT, PUBLIC ENGAGEMENT, COMMUNICATION, DISSEMINATION
2. Disease-related research
Neuroscientific Research aimed at understanding a disease.
Topic 11. Neuro Developmental disorders
Neurodevelopmental disorders are impairments of the growth and development of the brain and/or central nervous system. A narrower use of the term refers to a disorder of brain function that affects emotion, learning ability, self-control and memory which unfolds as an individual develops and grows.
11AAutism spectrum disorders Includes autism and Asperger syndrome. Individuals on the spectrum often experience difficulties with social communication and interaction and restricted, repetitive patterns of behaviour, interests, or activities *11B Attention-Deficit/Hyperactivity Disorder*

It is characterized by difficulty paying attention, excessive activity and acting without regards to consequences, which are otherwise not appropriate for a person's age.[1][2] There are also often problems with regulating emotions.

11CIntellectual disability

Characterized by significantly impaired intellectual and adaptive functioning.

11DMotor disorders

Are disorders of the nervous system that cause abnormal and involuntary movements. They can result from damage to the motor system. They include developmental coordination disorder, stereotypic movement disorder, and the tic disorders including Tourette syndrome.

11EOther

NEURODEVELOPMENTAL, AUTISM, ADHD, INFANT, CHILD, LEARNING DEFICIT, RETARDATION, INTELLECTUAL DISABILITY, DYSLEXIA, DYSCALCULIA, TRISOMY

Topic 12. Psychiatric diseases

A behavioural or mental pattern that causes significant distress or impairment of personal functioning. Such features may be persistent, relapsing and remitting, or occur as a single episode. Many disorders have been described, with signs and symptoms that vary widely between specific disorders. Such disorders may be diagnosed by a mental health professional. The causes of mental disorders are often unclear. Theories may incorporate findings from a range of fields. Mental disorders are usually defined by a combination of how a person behaves, feels, perceives, or thinks. This may be associated with particular regions or functions of the brain, often in a social context.

12ASchizophrenia Spectrum and Other Psychotic Disorders

12BAffective disorders

Or mood disorders. The main types of affective disorders are depression, bipolar disorder

12CAnxiety and fear-based disorders

Social anxiety: anxiety caused by social situations.
Post-traumatic stress disorder: anxiety, fear, and flashbacks caused by a traumatic event
Generalized anxiety disorder: anxiousness and fear in general, with no particular cause
Panic disorder: anxiety that causes panic attacks
Obsessive-compulsive disorder: obsessive thoughts that cause anxiety and compulsive actions

12DAddiction and drugs of abuse

Alcohol, opioids, Methamphetamine, Anabolic steroids, Club drugs, Cocaine, Heroin, Inhalants, Marijuana

12EOther

SCHIZOPHRENIA, PSYCHOSIS, PANIC, PSYCHIATRIC, NARCISSIST, DISSOCIATIVE, NCD, BIPOLAR, DYSTHYMIA, OBSESSIVE, ANOREXIA, ADDICTION, SEXUAL DYSFUNCTION, PARANOIA, DEPRESSION, PHOBIA, ANXIETY, BULIMIA, BORDERLINE, DICD, DELIRIUM, SCHIZOID, COMPULSIVE, IMPULSE CONTROL, POST TRAUMATIC, PSYCHIATRIC DISEASE

Topic 13. Sleep-Awake Disorders

Research on circadian rhythm and/or sleep-wake disorders. Such diseases occur when the body's internal clock (circadian system) does not work properly or is out of sync with the surrounding environment.

SLEEP, INSOMNIA, HYPERSOMNOLENCE, NARCOLEPSY, PARASOMNIAS, SLEEP AWAKE DISORDERS, CIRCADIAN

Topic 14: Neurological Disorders

Neurological disorders are diseases of the brain, spine and the nerves that connect them

14AEpilepsy

Epilepsy is a disorder characterized by recurrent seizures. Seizures are caused by abnormal activity of nerve cells

14BStroke

When a stroke occurs, a blood vessel in the brain becomes blocked or bursts, sometimes causing permanent brain injury or even death.

14CPeripheral Nerve Diseases

Peripheral neuropathy is a common neurological disorder resulting from damage to the peripheral nerves.

14DMultiple Sclerosis

A chronic disease that affects the central nervous system, including the brain, spinal cord and optic nerves. Experts believe MS is an autoimmune disease caused by the immune system attacking and damaging the nervous system.

14EHeadache

Cluster Headaches; Migraine; Tension Headaches.

14FOther

Arteriovenous Malformation; Brain Aneurysm; Dural Arteriovenous Fistulae; Post-Herpetic Neuralgia;

SEIZURE, NEUROLOGICAL, NEUROPATHIC, HEADACHE, MIGRAINE, EPILEPSY, BACK PAIN, BRAIN TUMOUR, RLS, CEREBRAL HAEMORRHAGE, STROKE, SCLEROSIS, MULTIPLE SCLEROSIS, SPINAL CORD, NEUROLOGICAL DISEASE

Topic 15: Neurodegenerative Disorders

Neurodegenerative disease is an umbrella term for a range of conditions which primarily affect the neurons in the human brain. Neurons are the building blocks of the nervous system which includes the brain and spinal cord. Neurons normally don't reproduce or replace themselves, so when they become damaged or die, they cannot be replaced by the body. Neurodegenerative diseases are incurable and debilitating conditions that result in progressive degeneration and / or death of nerve cells. This causes problems with movement (called ataxias), or mental functioning (called dementias).

15AAlzheimer's disease (AD) and other dementias

Alzheimer disease (AD), vascular dementia, dementia with Lewy bodies, and frontotemporal dementia

15BParkinson's disease (PD) and PD-related disorders

A slowly progressive degenerative disorder of specific areas of the brain. It is characterized by tremor when muscles are at rest (resting tremor), increased muscle tone (stiffness, or rigidity), slowness of voluntary movements, and difficulty maintaining balance (postural instability). In many people, thinking becomes impaired, or dementia develops.

15CPrion disease

Prion diseases comprise several conditions. A prion is a type of protein that can trigger normal proteins in the brain to fold abnormally. The most common form of prion disease that affects humans is Creutzfeldt-Jakob disease (CJD).

15DMotor neurone diseases (MND)

A rare condition that progressively damages parts of the nervous system. This leads to muscle weakness, often with visible wasting. It is also known as amyotrophic lateral sclerosis (ALS) and occurs when specialist nerve cells in the brain and spinal cord called motor neurones stop working properly.

15EHuntington's disease (HD)

HD is a fatal genetic disorder that causes the progressive breakdown of nerve cells in the brain. It deteriorates a person's physical and mental abilities usually during their prime working years and has no cure.

15FSpinocerebellar ataxia (SCA)

Is a term referring to a group of hereditary ataxias that are characterized by degenerative changes in the part of the brain related to the movement control (cerebellum), and sometimes in the spinal cord. There are many different types of SCA, and they are classified according to the mutated (altered) gene responsible for the specific type of SCA. The types are described using "SCA" followed by a number, according to their order of identification: SCA1 through SCA40 (and the number continues to grow). The signs and symptoms may vary by type but are similar, and may include an uncoordinated walk (gait), poor hand-eye coordination, and abnormal speech (dysarthria).

15GSpinal muscular atrophy (SMA)

SMA is a genetic disease affecting the central nervous system, peripheral nervous system, and voluntary muscle movement (skeletal muscle).

15HOther

NEURODEGENERATIVE, AGGREGAT, SCA, DEMENTIA, AMYLOID, MISSFOLD, TAU, ALZHEIMER, PARKINSON, ALS, MOTOR NEURON DISEASE, HUNTINGTON, PRION, AMYOTROPHY, AMYOTROPHIC LATERAL SCLEROSIS, SPINAL MUSCULAR ATROPHY, SPINOCEREBELLAR ATAXIA

Topic 16: Neurosurgical Diseases

Neurosurgical diseases are disorders of the central and peripheral nervous system requiring a surgical treatment. The medical specialty involved with the prevention, diagnosis, surgical therapy, and rehabilitation of illnesses affecting any part of the nervous system including the brain, spinal cord, peripheral nerves, and extra-cranial cerebrovascular system is referred to as neurological operation. Crises like intracranial drain and neuro injury are fundamentally associated with most of the neurosurgery. Intracerebral drain being the primary driver of dismalness and mortality brings about influencing between 37,000 and 52,400 patients every year in the United States.

16ASpinal Cord Injury

Is damage to the spinal cord that causes temporary or permanent changes in its function. Symptoms may include loss of muscle function, sensation, or autonomic function in the parts of the body served by the spinal cord below the level of the injury.

16BTraumatic Brain Injury/Head trauma

Sudden damage to the brain caused by a blow or jolt to the head. Any sort of injury to your brain, skull, or scalp.

16CNeuro Oncology

The study of brain and spinal cord neoplasms, many of which are (at least eventually) very dangerous and life-threatening (astrocytoma, glioma, glioblastoma multiforme, ependymoma, pontine glioma, and brain stem tumors are among the many examples of these). Among the malignant brain cancers, gliomas of the brainstem and pons, glioblastoma multiforme, and high-grade (highly anaplastic) astrocytoma are among the worst.

16DOther

BRAIN INJURY, SPINAL CORD INJURY, HEAD TRAUMA, TRAUMATIC BRAIN INJURY, NPH, EXTERNAL INSULT, NEUROSURG, BRAIN TUMOR

3. Research tools

Research on the tools that are used in neuroscience to study, diagnose and treat the brain.

Topic 17: Therapy

Research investigating a training, therapy or treatment (which is intended to relieve or heal a brain disorder).

CELL THERAPY, GENE THERAPY, IMMUNOTHERAPY, REHABILITATION, COMPOUND, NEUROREHABILITATION, THERAPY, BRAIN STIMULATION, NEURO-REMEDIATION, SOCIAL REHABILITATION, DRUG, TREATMENT, PSYCHO REHABILITATION, OPTOGENETIC THERAPY.

Topic 18: Diagnostics & Brain imaging

18ADiagnostics

Research focused on the detection and identification of a brain disorder.

18BBrain Imaging

Research focusing on/using fMRI, EEG, MEG, PET, and other brain imaging techniques.

MAGNETIC RESONANCE IMAGING, BLOOD SAMPLE, CSF SAMPLE, TOMOGRAPH, DTI, CEREBROSPINAL FLUID, MRI, DIAGNOSIS, BIOMARKER, NUCLEAR MAGNETIC

Topic 19: Omics

Technologies that measure some characteristic of a large family of cellular molecules, such as genes, proteins, or small metabolites, have been named by appending the suffix “-omics,” as in “genomics.” Omics refers to the collective technologies used to explore the roles, relationships, and actions of the various types of molecules that make up the cells of an organism.

OMICS, EPIGENETIC, TRANSCRIPTOMICS, MICROBIOMICS, LIPOMICS, GENOMICS, PROTEOMICS

Topic 20: Animal Model

Animal model refers to the induction in a non-human animal a disease, psychological or psychopathological process that is similar to a human condition. The use of model organisms allows researchers to investigate processes and disease states in ways which would be inaccessible in a human patient, performing procedures on the non-human animal that imply a level of harm that would not be considered ethical to inflict on a human. In order to serve as a useful model, a modelled disease must be similar in aetiology (mechanism of cause) and function to the human equivalent. Animal models are used to learn more about a disease, its diagnosis and its treatment.

TRANSGENIC, OPTOGENETIC, RODENT, ANIMAL MODEL, MAMMALS, PRIMATE, RAT, DROSOPHILA, MOUSE, ZEBRA FISH, ELEGANS, VERTEBRATE, INVERTEBRATE, ANIMAL

Topic 21: In Vitro

The term refers to studies of biological properties that are done in a test tube (i.e. in a glass vessel) rather than in a human or animal. In vitro studies are often contrasted to in vivo ("in life") studies which are done inside an organism. In vitro studies allow scientists to isolate specific cells, bacteria, and viruses and study them without the distractions of having to look at a whole organism.

VITRO, STEM CELL, HESCS, NPCS, ORGANOIDS, CELL CULTURE, IPSC, REPROGRAMMING, INDUCED, PLURIPOTENT, HUMAN EMBRYONIC, STEM, NEURAL PRECURSOR

2.3. Further Topic Information

Here below you find more specific information about the topics. Keep this information in mind during the categorisation of the abstracts.

Topic 1: Neural Function (Ref. FENS Classification)

- Cell excitability
  - Intrinsic membrane properties
  - Action potentials
  - Nerve conduction
- Ion channels
  - Sodium channels
  - Potassium channels
  - Calcium channels
  - Chloride channels
  - TRP channels
  - Other channels
- Intracellular dynamics
  - Signal transduction pathways
  - Cytoskeleton and cell motility
  - Metabolism
  - Mitochondria
  - RNA
- Gene regulation
  - Epigenetics
  - Transcription and translation
  - Transciptomics and proteomics
- Epigenetic mechanisms
- Cell types
  - Excitatory neuronal subtypes
  - Inhibitory interneuron subtypes
  - Astrocytes
  - Oligodendrocyte lineage subtypes
  - Microglia
- Myelination
- Synaptic transmission
  - Presynaptic structures
  - Neurotransmitter release mechanism
  - Postsynaptic structures
  - Electrical synapses and gap junctions
  - Other
- Neurotransmitters and their receptors
  - Glutamate
  - GABA and glycine
  - Acetylcholine
  - Monoamines
  - Nitric oxide and other gases
  - Opiates
  - Neuropeptides
  - Purines
  - Endocannabinoids
  - Other
- Transporters
  - Glutamate

    - Inhibitory transmitters
    - Monoamines
    - Other
- Synaptic integration
    - Dendritic signal processing
    - Dendritic spines
    - Excitation/inhibition balance
- Synaptic plasticity
    - Short-term plasticity
    - LTP/LTD: mechanisms, physiology and behaviour
    - Homeostatic plasticity
    - Structural plasticity
    - Neuromodulators
    - Other
- Glia-neuron interactions
    - Astrocyte-neuron interactions
    - Microglia-neuron interactions
    - Oligodendrocyte-neuron interactions
    - Other

Topic 2: Neuronal development (Ref. FENS Classification)

- Development and Stem Cells
- CNS patterning
- Neurogenesis and gliogenesis
    - Stem cells: basic biology
    - Cell lineage and cell fate specification
    - Neuronal differentiation
    - Glial differentiation
    - Adult stem cells and adult neurogenesis
- Development of neural systems
    - Early neuronal activity
    - Assembly of neural circuits
    - Molecular and genetic specification of circuits and cell types
    - Proliferation, migration and cell death
    - Tissue morphogenesis
    - Microglial and neuroimmune cells
- Synaptogenesis and activity-dependent development
    - Axon growth and guidance
    - Dendrite growth and branching
    - Synapse formation
    - Activity-dependent growth and remodelling
- Molecular signals and their receptors
    - Neurotransmitters
    - Neurotrophins and other growth factors
    - Cytokines
    - Morphogens and others
- Environmental factors
- Transplantation and regeneration
    - Embryonic stem cells, induced pluripotent stem cells
    - Molecular reprogramming of neurons and glial
    - Organoids

Topic 3: Sensory and Motor Systems (Ref. FENS Classification)

- Chemical senses

    - Olfaction
    - Taste
- Vestibular system
    - Vestibular organ
    - Brainstem nuclei
- Auditory system
    - Inner ear
    - Subcortical pathways
    - Auditory cortex
- Vision
    - Retina
    - Subcortical pathways
    - Visual cortex: V1 and higher areas
    - Visual cognition
    - Visuomotor processing
- Tactile/somatosensory system
    - Peripheral receptors
    - Brainstem
    - Thalamus and neocortex
    - Whisker system
- Association cortex
- Multisensory integration
- Pain
    - Peripheral receptors
    - Spinal cord processing
    - Thalamic and cortical processing
    - Chronic pain
    - Somatic, muscle and visceral
    - Pharmacological and non-pharmacological analgesia
- Motor neurons and muscle
- Motor control
    - Spinal cord
    - Brainstem
    - Cerebellum
    - Basal ganglia
    - Motor Cortex
- Motor Control
    - Spinal cord
    - Voluntary movements
    - Eye movements
- Brain-machine interface

Topic 4: Cognition&Behavior (Ref. FENS Classification)

- Human studies
    - Attention and perception
    - Learning and long-term memory
    - Navigation and spatial memory
    - Fear and aversive learning and memory
    - Appetitive and incentive learning and memory
    - Reward and reinforcement
    - Working memory
    - Memory modulation, consolidation, and reconsolidation
    - Decision making and reasoning

    - Language and communication
    - Motivation and emotion
    - Associative, non-associative, and skill learning
    - Cognitive development and aging
    - Social cognition and behaviour
    - Neural circuit mechanisms
    - Physiology and imaging
    - Pharmacology
- Animal studies
    - Attention and perception
    - Learning and long-term memory
    - Navigation and spatial memory
    - Fear and aversive learning and memory
    - Appetitive and incentive learning and memory
    - Reward and reinforcement
    - Working memory
    - Memory modulation, consolidation, and reconsolidation
    - Decision making and reasoning
    - Language and communication
    - Motivation and emotion
    - Associative, non-associative, and skill learning
    - Cognitive development and aging
    - Social cognition and behaviour
    - Neural circuit mechanisms
    - Physiology and imaging
    - Pharmacology
- Neuroethology

Topic 5: Computational neuroscience/Robotics/Technology (Ref. FENS Classification)

- Data analysis
    - Single-cell modelling
    - Neural network models
    - Development, axonal patterning, and guidance
    - Brain connectivity
    - Sensorimotor control
    - Learning and memory
    - Social cognition and behaviour
    - Decision making
    - Consciousness
    - Computational clinical neuroscience
    - Neuro-robotics
    - Deep and machine learning
- Data driven modelling
    - Single cell modelling
    - Neural network models
    - Development, axonal patterning, and guidance
    - Brain connectivity
    - Sensorimotor control
    - Learning and memory
    - Social cognition and behaviour
    - Decision making
    - Consciousness
    - Computational clinical neuroscience

    - Neuro-robotics
    - Deep and machine learning
- Conceptual modelling and pure theory
    - Single cell modelling
    - Neural network models
    - Development, axonal patterning, and guidance
    - Brain connectivity
    - Sensorimotor control
    - Learning and memory
    - Social cognition and behaviour
    - Decision making
    - Consciousness
    - Computational clinical neuroscience
    - Neuro-robotics
    - Deep and machine learning

Topic 6: Disease aetiology (Ref. UKCRC Health Research Classification System)

- Biological and endogenous factors
    - genes and gene products, molecular, cellular and physiological structures and functions
    - biological factors linked to ethnicity, age, gender, pregnancy and body weight
    - endogenous biological factors or pathways involved in responses to infection or damage by external factors
    - metastases, degenerative processes, regeneration and repair
    - complications, reoccurrence and secondary conditions
    - bioinformatics and structural studies
    - development and characterisation of models
- Factors relating to physical environment
    - physical agents, occupational hazards, environmental surroundings, radiation and pollution
    - chemicals and nutrients
    - infection by pathogens and studies of infectious agents
- Psychological, social and economic factors
    - individual or group behaviours and lifestyle
    - cultural or religious beliefs or practices
    - ethnicity, age and gender differences
    - socioeconomic factors
- Surveillance and distribution
    - Observational studies, surveys, registries
    - Studies that track incidence, prevalence, morbidity, co-morbidity and mortality including ongoing monitoring of large-scale cohorts

Topic 7: Clinical Research (Ref. FDA)

- Treatment/Intervention Research:
    - Medication
    - Psychotherapy
    - New devices
    - New approaches to surgery or radiation therapy.
- Prevention Research:
    - Looks for better ways to prevent disorders from developing or returning.
    - Medicines
    - Vitamins
    - Vaccines
    - Minerals
    - Lifestyle Changes.

- Diagnostic Research:
  - Refers to the practice of looking for better ways to identify a particular disorder or condition.
- Screening Research:
  - Aims to find the best ways to detect certain disorders or health conditions.
- Quality of Life Research:
  - Explores ways to improve comfort and the quality of life for individuals with a chronic illness.
- Genetic studies:
  - Aim to improve the prediction of disorders by identifying and understanding how genes and illnesses may be related.
  - Research in this area may explore ways in which a person's genes make him or her more or less likely to develop a disorder.
  - This may lead to development of tailor-made treatments based on a patient's genetic make-up.
- Epidemiological studies:
  - Seek to identify the patterns, causes, and control of disorders in groups of people.
- Phases of clinical trials:
  - when clinical research is used to evaluate medications and devices
  - Clinical trials are a kind of clinical research designed to evaluate and test new interventions such as psychotherapy or medications. Clinical trials are often conducted in four phases. The trials at each phase have a different purpose and help scientists answer different questions.
- Phase I trials:
  - Researchers test an experimental drug or treatment in a small group of people for the first time. The researchers evaluate the treatment's safety, determine a safe dosage range, and identify side effects.
- Phase II trials:
  - The experimental drug or treatment is given to a larger group of people to see if it is effective and to further evaluate its safety.
- Phase III trials:
  - The experimental study drug or treatment is given to large groups of people. Researchers confirm its effectiveness, monitor side effects, compare it to commonly used treatments, and collect information that will allow the experimental drug or treatment to be used safely.
- Phase IV trials:
  - Post-marketing studies, which are conducted after a treatment is approved for use by the FDA, provide additional information including the treatment or drug's risks, benefits, and best use.

Topic 8: Health and Social Care (Ref. OECD)

- Social care:
  - Focused on providing assistance with activities of daily living, maintaining independence, social interaction, enabling the individual to play a fuller part in society, protecting them in vulnerable situations, helping them to manage complex relationships and (in some circumstances) accessing a care home or other supported accommodation.
- Health care:
  - Care related to the treatment, control or prevention of a disease, illness, injury or disability, and the care or aftercare of a person with these needs (whether or not the tasks involved have to be carried out by a health professional).
  - Curative care
  - Rehabilitative care
  - Long-term care (health)
  - Ancillary services (non-specified by function)
  - Medical goods (non-specified by function)
  - Preventive care
  - Governance and health system and financing administration
  - Other health care services not elsewhere classified (n.e.c.)
  - Memorandum items: reporting items

        - Total pharmaceutical expenditure
        - Traditional complementary alternative medicines
        - Prevention and public health services (according to SHA 1.0)
    - Memorandum items: health care related
        - Long-term care (social)
        - Health promotion with a multi-sectoral approach

Topic 9: Public/Patient Engagement & Involvement

Both involvement and engagement activities are very beneficial to those conducting research. Engagement activities, including presenting to patient groups, participating in charity engagement events and institute open days, may be the most appropriate way to gain patient insight for some forms of research. However, if these activities are entered into with an open mind and a willingness to listen and be guided by new perspectives, they can form the foundation for meaningful involvement activities in future.

Patient/Public involvement: Where members of the public/patients are actively involved in research projects and in research organisations.

- Patient/Public engagement: Information and knowledge about research is provided, and disseminated.
- Patient/Public consultation
- Patient/Public advise as members of advisory boards
- Patient/public collaboration: As research partners
- Patient/Public control: as steering group committee
- Community based participatory research

Topic 10: Neuro-immunology

- Blood brain barrier
- CNS Autoimmune diseases:
    - Multiple sclerosis and spectrum disorders
    - Encephalitis
    - Paraneoplastic diseases
- Lymphocyte
- MS

Topic 11. Developmental disorders (Ref. DSMV)

11AAutism spectrum disorders

11BAttention-deficit/hyperactivity disorder

11CIntellectual disability

- Including specific Learning Disorder

11DMotor disorders

11EOther

- Disruptive Mood Dysregulation Disorder: A New Childhood Disorder
- Trauma- and Stressor-Related Disorders
- Disruptive, Impulse-Control, and Conduct Disorders
- Attachment Disorder

Topic 12. Psychiatric Diseases (Ref. DSMV)

12ASchizophrenia Spectrum and Other Psychotic Disorders

- Schizophrenia
- Dissociative Disorders
    - Depersonalization Disorder
    - Dissociative Amnesia
    - Dissociative Fugue
    - Dissociative Identity Disorder
    - Dissociative Disorder Not Otherwise Specified (NOS)

12BAffective disorders

- Bipolar Disorder
    - Major Depressive Episode
    - Hypomanic Episode
    - Manic Episode
    - Mixed Specifier (Formerly Mixed Episode)
- Depression
    - Postpartum Depression
    - Seasonal Affective Disorder (SAD)
    - See Depressive Disorder with Seasonal Pattern)

12CAnxiety and fear-based disorders

- Generalized Anxiety Disorder
- Panic Disorder
- Phobias
- Social Anxiety Disorder
- Obsessive-Compulsive Disorder
- Posttraumatic Stress Disorder (PTSD)

12DAddiction and drugs of abuse

- Alcohol or Substance Use Disorder
- Opioid Use Disorder Symptoms

12EOther

- Adult Attention Deficit/Hyperactivity Disorder (ADHD/ADD)
- Feeding & Eating Disorders
    - Anorexia Nervosa
    - Binge Eating Disorder
    - Bulimia Nervosa
    - Pica
- Sexual & Paraphilic Disorders
    - Dyspareunia
    - Erectile Disorder (ED)
    - Exhibitionistic Disorder
    - Female & Male Orgasmic Disorders
    - Female Sexual Arousal Disorder
    - Fetishistic Disorder
    - Frotteuristic Disorder
    - Hypoactive Sexual Desire Disorder
    - Persistent Genital Arousal Disorder (PGAD; not a recognized diagnostic category at this time)
    - Premature (Early) Ejaculation
    - Sex Addiction (not a recognized diagnostic category at this time)
    - Sexual Masochism and Sadism
    - Transvestic Disorder
    - Vaginismus
    - Voyeuristic Disorder
- Personality Disorders
    - Antisocial Personality Disorder
    - Avoidant Personality Disorder
    - Borderline Personality Disorder
    - Dependent Personality Disorder
    - Histrionic Personality Disorder
    - Multiple Personality Disorder, see Dissociative Identity Disorder
    - Narcissistic Personality Disorder
    - Obsessive-Compulsive Personality Disorder
    - Paranoid Personality Disorder

- Schizoid Personality Disorder
- Schizotypal Personality Disorder

Topic 13. Sleep-Awake Disorders (FENS; DSMV)

- Biological rhythms and sleep
- Clocks
- Sleep: molecular, cellular, and pharmacology
- Sleep: circuits, network activity, and behaviour
- Circadian Rhythm Sleep-Wake Disorder
- Hypersomnolence (Hypersomnia, Primary)
- Insomnia Disorder
- Nightmare Disorder
- Narcolepsy
- Rapid Eye Movement Sleep Behaviour Disorder
- Restless Legs Syndrome
- Non-Rapid Eye Movement Sleep Arousal Disorders (Sleep Terror Disorder & Sleepwalking Disorder)

Topic 14: Neurological Disorders (Ref., FENS)

14AEpilepsy

14BStroke

- Ischemia

14CPeripheral nerve diseases

- Demyelinating
- Axonopathies
- Immune neuropathies

14DMultiple sclerosis

14EHeadache

14FOther

- CNS autoimmune diseases
  - Encephalitis
  - Paraneoplastic diseases

Topic 15: Neurodegenerative Disorders (Ref. FENS)

15AAlzheimer's disease (AD) and other dementias

- APP and Abeta
- Tau and other pathological proteins
- Molecular and cellular mechanisms
- Cognitive function, imaging and biomarkers
- Therapeutic strategies

15BParkinson's disease (PD) and PD-related disorders

- Molecular and cellular mechanisms
- Human studies and therapies
- Animal models

15CPrion disease

15DMotor neurone diseases (MND)

- ALS and FTD spectrum disorders
- Motor neuron and neuromuscular diseases

15EHuntington's disease (HD)

15FSpinocerebellar ataxia (SCA)

15GSpinal muscular atrophy (SMA)

15HOther

Topic 16: Neurosurgical Diseases

16ASpinal Cord Injury
16BTraumatic Brain Injury/Head Trauma
16CNeuro Oncology
16DOther

Topic 17: Therapy

- Lifestyle changes: to either prevent or minimize the impact of such conditions
- Physiotherapy: to manage the symptoms and restore some function
- Pain management: as many impairments can be associated with considerable discomfort
- Medication: to either restore function or prevent a worsening of the patient's condition
- Cognitive therapy

Topic 18: Diagnostics & Brain Imaging

Topic 18A: Diagnostics

- Laboratory screening tests of blood, urine, or other body fluids
- Genetic testing
- Biopsy
    - Muscle
    - Nerve
    - Skin
- Cerebrospinal fluid analysis
- EMG and nerve conduction studies
- Evoked responses
- Myelography
- Polysomnogram
- Thermography
- Ultrasound imaging
- X-rays

Topic 18B: Brain Imaging

- CT
- fMRI
- SPECT
- PET
- EEG
- MEG
- TMS
- tDCS

Topic 19: Omics

- Genomics, "the study of genes and their function" (Human Genome Project (HGP), 2003)
- Proteomics, the study of proteins
- Metabolomics, the study of molecules involved in cellular metabolism
- Transcriptomics, the study of the mRNA
- Glycomics, the study of cellular carbohydrates
- Lipomics, the study of cellular lipids

Topic 20: Animal Model

- Non-human primates
- Rodents
- the fruit fly D. melanogaster
- the zebrafish D. rerio

- the roundworm C. elegans
- Bee

Topic 21: In Vitro

- Nanotechnology
- Brain slices
- Brain organoids
- Cultured cells from post-mortem human brain tissue
    - Access to a tissue bank for post-mortem brain tissue samples supports the isolation of astrocytes and enriched microglia cultures to study multiple neurological diseases (e.g., Alzheimer's disease, Parkinson's disease)
- Human immortalized foetal brain cells:
    - The cells are derived from ventral mesencephalon and immortalized via retroviral transduction. These cells are differentiated into neurons that show dopaminergic-like phenotypes and are a good model for Parkinson's disease.
- Human embryonic stem cells (hESCs):
    - The pluripotency status of the ES cells is established using Oct4 staining pre- and post-differentiation. The ES cells can be differentiated into neuronal precursor cells (NPCs) and ultimately striatal neurons that are tested using a panel of antibody markers and/or branched DNA assays. Neuronal precursor cell markers include Pax6, FoxG1, FoxP1, Sox1, and Nestin, while some of the markers for mature neurons include MAP2, PSD95, Synaptophysin, and DARPP32.
- Human-induced pluripotent stem cells (iPSC):
    - iPS cells are derived from reprogramming patient or controlling somatic cells. The iPS cells are differentiated into neurons using established protocols, followed by testing using a panel of neuronal specific markers.
- Rodent primary neurons derived from established in vivo disease models
- Established neuronal cells from various brain compartments validated using morphology and functional readouts across multiple diseases and readouts, including neuroinflammation and neuroregeneration.

2.4. Topic classification procedure

2. 2.4.1. Steps to follow

- Read the **classification topic manual** and make sure you understand each topic (definition, keywords, further info).
- Read the **EU brain project abstract**
- Focus on the **aim and methodology** of the EU brain project abstract.
- Highlight the parts that you believe are related to a topic.
- **Check and validate (= accept)** the topics assigned by the **machine learning** algorithm and write them in the **Supervised_Validated Column**.
- **Manually assign the corresponding topics**, or **NBR** (not brain related)/**NA** (not assigned) to the EU brain project abstract.
- **Write the topic numbers separated by a comma in the column manual classification.**

2. Tips and Tricks

- **Focus on the aim and methodology** of the project, not on the potential and possible impacts, or effects on certain diseases.
- Only **focus on the main topics** of the project: Ideally, add 1 or 2 topics of each category (basic science; disease area; research tools) but add more if needed.
- Only **assign a disease topic when the project examines a specific disease**, not just a phenomenon linked to diseases.
- When assigning disease topics, **specify the disease: A, B, C, D, …**
- If you consider the abstract to be **not brain related**, write **NBR** (= Not Brain Related)
- If you do not know or consider the abstract to be too complicated, write **NA** (not assigned)
- **TAKE YOUR TIME.**

ANNEX II. HBP budget

To calculate the HBP budget for the period between 2007 and 2019, the ramp-up phase, SGA1 and SGA 2 phases were summed up. This results in a total amount of 291.16 M€. More information can be found in the table here below. Therefore, the present report does not take into account the last funding phase of the HBP (SGA3) started in April 2020 and ending in March 2023.

Phase	**EC (million)**	**Partners (million)**	**Total (million)**
Ramp-up (41 months)	54 (74.5%)	18,5 (25.5%)	72,5
SGA1	89 (81.2%)	20,5 (18.8%)	109,5
SGA2	88 (80.6%)	21,16 (19.4%)	109,16
Total for the period between 2007-2019	**231**	**60,16**	**291,16**

ANNEX III. Budget (in €) for brain research in Europe between 2007 and 2019

Country	Total	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
DE	926.121.378	0	68.690.039	58.252.813	79.584.671	70.684.356	73.712.096	125.363.436	58.641.535	77.294.314	116.919.636	71.579.659	103.896.836	21.501.987
UK	909.789.159	200.000	55.527.948	50.520.566	78.109.076	63.958.111	77.067.505	121.279.311	58.653.760	93.213.010	124.094.299	71.662.002	96.480.766	19.022.804
FR	642.010.614	0	31.932.253	39.758.775	51.610.690	36.249.529	54.655.256	85.563.060	59.804.063	64.337.442	83.087.429	53.857.361	62.558.638	18.596.117
NL	455.996.706	0	20.368.069	11.461.688	30.923.406	35.810.768	40.588.807	61.571.424	39.875.776	41.501.403	66.031.429	40.981.235	47.683.924	19.198.776
IT	424.693.131	0	41.493.315	24.602.903	38.850.383	33.609.347	34.395.365	61.507.082	31.346.212	25.135.504	51.100.833	35.461.601	36.237.302	10.953.284
ES	362.879.339	210.417	27.471.539	11.812.191	23.332.236	31.925.559	38.692.074	40.067.454	17.820.581	35.879.753	46.110.335	36.647.059	50.526.159	2.383.983
SE	246.038.874	0	18.860.565	14.076.513	12.666.371	21.769.436	28.228.262	28.572.102	16.840.245	24.933.768	27.068.475	19.828.643	22.400.635	10.793.859
BE	203.483.473	0	11.421.655	2.852.339	13.740.289	11.485.186	19.512.232	23.024.720	22.964.110	15.898.527	22.871.478	16.625.493	34.885.060	8.202.383
AT	139.694.458	100.000	9.029.549	7.113.604	17.745.425	7.211.949	11.429.477	15.324.394	7.364.635	15.159.142	18.090.640	16.500.876	12.797.444	1.827.322
DK	118.527.172	0	9.033.980	2.987.782	12.674.396	7.437.820	12.419.718	9.869.033	5.178.195	10.559.465	18.199.148	14.511.013	13.565.083	2.091.540
FI	104.764.611	0	8.595.240	8.699.539	6.530.336	3.486.994	8.017.216	21.255.876	6.598.360	7.135.498	11.310.661	12.197.639	6.571.426	4.365.827
PT	81.418.546	100.000	5.739.961	5.472.724	5.041.758	5.847.165	4.622.155	6.164.220	4.218.665	7.372.916	12.580.627	5.634.710	13.548.496	5.075.149
HU	71.456.547	0	3.998.045	2.900.440	4.258.682	5.215.423	9.073.821	9.232.171	3.003.212	3.395.562	10.341.576	8.390.728	11.646.887	0
IE	65.999.474	0	2.952.373	1.849.734	6.235.449	2.832.047	7.497.885	9.280.008	5.659.900	7.274.786	7.871.116	7.027.237	4.362.924	3.156.015
PL	38.673.967	100.000	4.156.652	1.298.274	2.087.607	5.599.137	2.097.398	5.541.060	2.230.651	4.015.924	2.957.505	5.139.334	2.772.388	678.039
CZ	27.975.930	0	2.266.638	868.285	5.403.719	100.000	3.062.883	6.567.505	426.193	1.176.746	3.506.924	3.562.488	1.034.548	0
LU	14.125.511	0	0	0	606.767	862.973	1.198.467	657.307	1.972.852	2.875.034	3.499.250	500.449	685.757	1.266.656
EE	13.699.922	0	2.548.178	240.656	864.516	394.106	2.231.384	3.128.716	114.600	1.115.108	764.418	1.604.763	693.477	0
CY	11.733.224	0	1.275.649	682.312	264.952	1.378.976	668.006	1.013.900	343.800	3.317.574	817.893	239.999	1.730.163	0
RO	10.844.807	0	1.234.958	445.284	486.421	358.833	1.312.215	0	1.930.118	1.856.455	1.810.774	492.765	916.984	0
HR	9.660.042	0	0	0	0	0	4.283.939	1.099.814	192.338	136.219	354.555	232.923	3.360.253	0
SK	5.756.034	0	912.632	285.690	254.646	388.506	890.236	697.649	0	1.375.922	366.334	210.000	374.418	0
LT	3.156.364	0	0	761.803	491.667	732.387	202.042	0	0	0	837.686	0	130.780	0
BG	3.134.544	0	487.409	0	1.080.046	446.390	331.774	0	0	198.733	354.555	235.636	0	0
LV	1.202.953	0	0	0	0	0	0	0	0	0	736.103	188.100	278.750	0
MT	747.527	0	0	0	0	319.111	0	428.416	0	0	0	0	0	0
GR	403.875	0	0	0	0	0	403.875	0	0	0	0	0	0	0
SL	333.333	0	0	0	0	0	0	0	0	0	0	0	333.333	0

ANNEX IV. How many and which topics were assigned to brain research projects in the database?

We evaluated the number of topics assigned to a project. Brain research experts could assign a minimum of 1 topic and a maximum of 21 topics to each project. On average, 4 to 5 topics were assigned to each project or 3 to 4 extra topics were added in addition to a primary topic. For example, if "Cognition and Behaviour" has been assigned to a project, on average 2.8 other topics were assigned to this project as well (see Table right below). In the other table, the number of projects in which two topics are assigned together, is presented.

Average number of topics in addition to the primary one.

Topic	Number of additional topics (Average)
Research area	
Cognition and Behaviour	2.8
Computational Neuroscience/robotics	2.72
Disease Aetiology	4.12
Neural Function	3.14
Sensory and Motor Systems	2.97
Neuronal Development	3.17
Neuro-Immunology	3.72
Clinical research	3.96
Health Care & Social Care	2.8
Public/Patient Engagement	3.43
Research tool	
Animal model	3.39
Therapy	3.72
Diagnostics&Neuroimaging	2.98
Omics	3.67
In vitro model	3.41
Disease area	
Neurodegenerative diseases	3.27
Neurological diseases	3.57
Psychiatric diseases	3.62
Neurodevelopmental disorders	3.72
Neurosurgical diseases	3.22
Sleep-Awake disorders	3.1

Number of projects in which two topics are assigned together.

Topic	Computational Neuroscience/ Robotics	Disease Aetiology	Neural Function	Sensory and Motor Systems	Neuronal Development	Neuro-Immunology	Clinical Research	Health & Social Care	Public/Patient Engagement	Animal model	Therapy	Diagnostics and Neuroimaging	Omics	In vitro model	Neurodegenerative	Neurodevelopmental	Neurological	Neurosurgical	Psychiatric	Sleep-Awake
Cognition and Behaviour	366	91	366	377	66	16	152	118	53	440	107	542	199	65	56	70	49	15	99	14
Computational Neuroscience/robotics	-	60	184	259	38	8	138	144	53	182	123	313	93	82	75	40	68	30	43	7
Disease Aetiology	-	-	156	25	39	41	153	29	27	186	106	145	171	116	158	49	64	25	74	2
Neural Function	-	-	-	201	166	55	100	18	17	627	117	301	401	325	151	44	68	36	69	14
Sensory and Motor Systems	-	-	-	-	45	8	93	70	16	297	92	280	124	56	26	19	60	21	12	4
Neuronal Development	-	-	-	-	-	15	16	17	7	199	34	49	161	122	27	15	21	21	16	1
Neuro-Immunology	-	-	-	-	-	-	40	9	5	82	54	35	54	62	25	5	35	16	9	2
CLINICAL RESEARCH	-	-	-	-	-	-	-	145	83	118	243	271	120	70	142	60	109	49	114	7
Health Care & Social Care	-	-	-	-	-	-	-	-	73	27	135	137	24	10	75	33	62	14	56	3
Public/Patient Engagement	-	-	-	-	-	-	-	-	-	22	49	60	16	13	44	16	16	10	32	4
Animal model	-	-	-	-	-	-	-	-	-	-	201	316	497	320	169	54	110	54	73	19
Therapy	-	-	-	-	-	-	-	-	-	-	-	174	142	127	165	36	126	75	70	4
Diagnostics&Neuroimaging	-	-	-	-	-	-	-	-	-	-	-	-	197	100	178	66	128	58	98	19
"Omics"	-	-	-	-	-	-	-	-	-	-	-	-	-	254	164	43	60	40	65	6
In vitro model	-	-	-	-	-	-	-	-	-	-	-	-	-	-	132	25	65	54	21	5
Neurodegenerative diseases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	26	8	11	4
Neurodevelopmental disorders	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	3	19	1
Neurological diseases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	8	1
Neurosurgical diseases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0
Psychiatric diseases	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4

ANNEX V. Number of projects and budget between 2007 and 2019 for each topic.

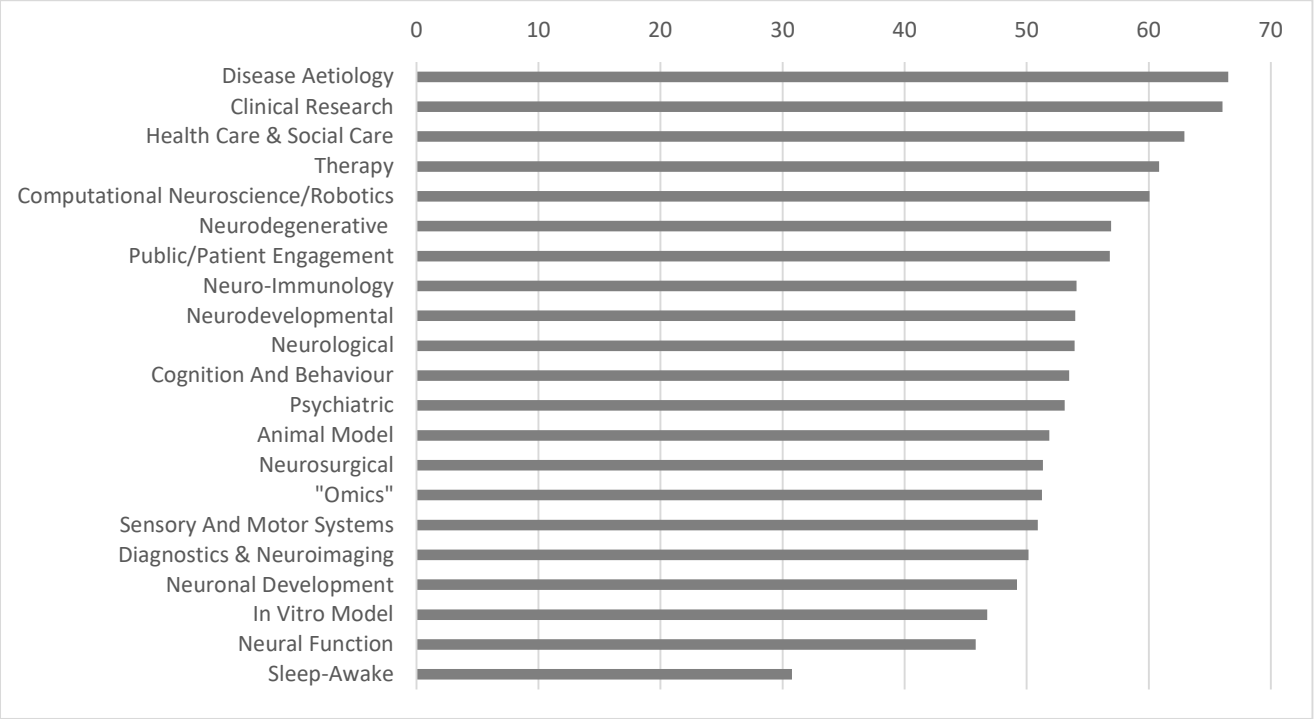
	Project starting year																							
	2007		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€
Research area																										
Cognition and Behaviour	2	200	68	107401	81	118465	75	126528	116	153981	99	152693	129	164912	143	151706	119	146715	186	261570	133	165912	156	236544	45	62561
Computational Neuroscience	1	100	35	108258	38	58654	40	75225	53	84878	49	85154	57	146845	63	66019	81	133869	106	271864	95	137037	129	225643	21	47828
Robotics	-	-	24	68092	10	31708	15	65708	31	67221	28	58134	27	114880	19	34924	23	46289	21	46298	24	21126	32	23328	7	13069
Disease Aetiology	3	300	24	49584	28	49066	30	111609	34	60404	45	98280	47	132182	61	97232	59	112479	58	250144	40	95789	32	96552	17	21610
Neural Function	2	200	72	81461	95	105640	108	114138	101	84230	115	114970	123	175004	96	109509	115	125378	131	168109	100	104975	118	179846	40	38933
Sensory and Motor Systems	-	-	45	82181	43	56124	58	67736	69	80200	81	113346	87	117124	72	87809	68	96925	88	120597	98	102711	94	83737	22	33701
Neuronal Development	2	210	32	40868	31	32763	38	41135	33	33304	38	48626	37	73800	31	34359	36	61135	33	37679	28	24633	33	35048	10	17146
Neuro-Immunology	1	100	10	50769	7	18824	10	15401	10	22442	14	43234	17	41118	14	15487	34	49654	16	21073	23	40777	31	18453	9	8753
Clinical research	1	100	27	114468	29	68142	41	158868	40	107359	59	179946	67	223902	77	120208	70	167931	101	190999	75	144018	93	208470	18	31861
Health Care & Social Care	3	300	21	47396	21	28138	28	68576	31	84863	21	40700	44	144069	36	55435	57	150400	88	198241	67	117833	87	120055	11	24183
Public/Patient Engagement	-	-	9	40657	7	17772	14	28183	14	41189	16	50427	12	78309	19	32321	19	36013	30	80117	24	49491	43	75074	6	9881
Research tool																										
Animal model	6	600	72	157495	78	109912	97	178648	107	117457	127	179906	134	186689	138	160758	126	154858	140	192134	132	155297	152	218276	35	38590
Therapy	3	310	36	137137	31	61888	41	121452	65	114265	68	155411	58	99791	57	77540	59	104294	89	177064	79	154540	92	207718	9	12995
Diagnostics	1	100	11	58815	16	43668	14	58327	17	45663	26	67340	24	38228	28	43131	45	90915	55	227425	40	74347	43	130483	6	17409
Neuroimaging	-	-	46	99440	58	79945	74	105413	107	123106	95	141474	106	166442	115	141006	100	103979	144	207048	117	125651	127	89536	38	42928
omics	7	710	47	90662	56	74300	54	115470	78	82478	86	126076	87	148648	108	91639	99	136651	93	132698	71	81560	68	80638	20	21179
In vitro model	4	410	39	69056	41	42391	51	63453	54	32038	67	82068	69	122043	45	33685	83	109779	60	107062	51	75600	75	69414	11	15216
omics	7	710	47	90662	56	74300	54	115470	78	82478	86	126076	87	148648	108	91639	99	136651	93	132698	71	81560	68	80638	20	21179

	Project starting year																									
	2007		2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€
Neurodegenerative	1	100	32	102816	37	61043	45	87315	35	50280	56	109281	54	135291	63	89731	65	119307	66	143608	47	71077	49	47852	14	21914
AD	-	-	13	37042	12	19854	15	35685	13	11052	24	29678	22	71996	40	58685	28	49688	34	86126	21	30237	17	11505	8	14174
PD	-	-	6	25510	10	11483	17	34104	13	13947	12	27702	15	33718	18	32097	22	39857	19	22146	11	23152	13	14178	6	9045
HD	-	-	2	14444	3	1824	2	2200	-	-	3	1210	7	27935	3	3268	4	5890	3	2006	1	180	5	1565	1	170
MND	-	-	-	-	6	15741	1	174	2	9094	5	16746	4	16139	9	13760	4	8429	1	2447	4	2434	6	9959	-	-
SCA	-	-	1	1450	1	75	-	-	1	2999	1	925	1	1500	2	2786	3	2733	3	4200	1	2000	-	-	-	-
Prion	-	-	-	-	2	10978	1	100	1	201	2	2399	1	169	1	1461	1	2500	-	-	1	150	1	1832	-	-
SMA	-	-	-	-	1	2000	1	100	1	173	-	-	2	7500	2	1174	1	763	-	-	-	-	-	-	-	-
Neurodevelopmental	1	100	2	2749	5	10646	12	29984	18	21360	22	53501	10	33871	23	22999	26	35275	23	36910	19	31624	23	74661	5	9079
Autism	1	100	1	2580	2	4649	2	150	11	12140	6	29834	6	17751	8	15193	11	15154	11	19102	10	13430	12	65741	3	2629
ADHD	-	-	-	-	1	273	2	3239	-	-	1	6000	1	3723	3	1006	4	12438	5	12565	2	9359	-	-	-	-
Intellectual disability	-	-	-	-	1	100	-	-	2	1249	5	3515	1	222	5	5029	2	4639	1	5925	-	-	4	3118	-	-
Motor	-	-	-	-	-	-	-	-	2	6011	2	1324	-	-	3	585	-	-	1	178	1	1332	-	-	-	-
Neurological	1	100	15	54402	19	27580	17	13248	31	69529	30	59431	31	77070	26	38223	40	61532	41	79742	40	72387	51	76136	14	16999
Stroke	-	-	3	22062	2	3318	3	3503	15	49413	11	19902	5	9741	13	8987	14	24377	12	14189	12	23979	17	22269	3	4499
Epilepsy	-	-	2	5908	4	6708	6	3637	3	9582	3	402	11	42850	3	2548	6	9643	11	19814	9	5734	13	7320	3	3186
MS	-	-	3	14339	2	145	4	1445	3	335	5	21666	1	173	3	1931	5	9390	4	11528	4	24874	4	5902	2	441
Peripheral nerve	1	100	-	-	-	-	-	-	1	5922	-	-	1	263	2	4980	1	283	-	-	1	50	2	7881	-	-
Headache	-	-	1	1600	1	2467	-	-	1	100	-	-	-	-	1	5997	3	3832	-	-	-	-	-	-	-	-
Psychiatric	2	210	13	24223	12	21573	26	62549	28	42728	17	20286	28	70171	32	40410	24	28791	28	61290	35	42198	34	46429	9	14680
Affective	1	110	5	15245	3	12116	7	12696	7	8379	4	1707	6	2748	9	13663	8	15688	13	39367	7	7957	10	19430	3	7573
Schizophrenia	1	110	5	4300	4	15086	8	31116	9	16335	5	6048	6	13238	3	1456	7	8766	5	15692	9	6847	5	4988	2	3151
Anxiety	1	100	2	3655	2	2714	1	1382	5	3780	4	7961	6	9045	9	5715	2	5288	4	8367	9	13126	4	4333	3	9310
Addiction	-	-	-	-	5	8234	2	7500	3	10519	2	401	2	4825	4	1668	2	5114	4	16652	2	2820	3	864	1	1500

	Project starting year																					
	2008		2009		2010		2011		2012		2013		2014		2015		2016		2017		2018		2019	
	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€	n	k€
Neurosurgical	9	14551	6	8097	17	32168	16	6983	14	14000	19	52725	16	21641	18	27573	16	35869	34	46568	18	22667	6	7328
Neuro Oncology	1	1566	4	4702	6	16291	8	1271	11	3454	8	5747	8	6666	9	9789	5	9117	11	20451	9	16457	5	4828
Spinal Cord	2	3166	2	2592	7	13855	4	666	2	8046	7	9676	2	2022	4	11566	6	19292	7	11279	4	4770	-	-
TB I	2	1759	1	896	1	1641	2	3345	1	2500	5	37479	2	4516	3	4668	5	15769	12	12742	4	1390	-	-
Sleep-Awake	2	1458	2	339	3	250	3	1624	3	353	2	331	3	2353	5	4235	4	5625	6	5258	6	1249	-	-
Other	17	25900	12	19203	20	43655	16	17000	20	20508	21	44164	15	13085	20	26721	24	58064	22	29610	24	43582	5	7649

ANNEX VI. Which brain research topics receive more than 500K€/project?

For each research topic we also evaluated the percentage of received funding over 500K€. The percentage of projects receiving more than 500K€ is presented here below in the Figure. Details per year are presented in the table.

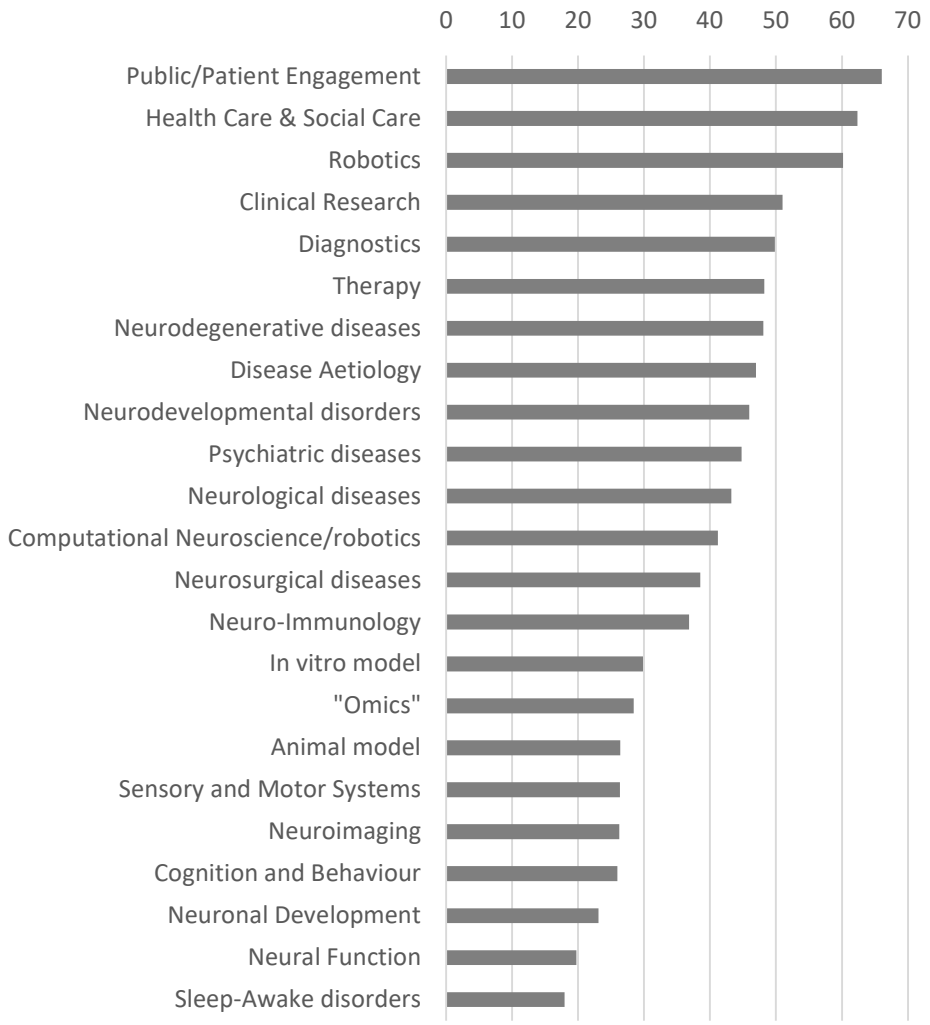


Percentage of projects per topic receiving more than 500K€.

Percentage of projects per topic and year receiving more than 500K€.												
Topics	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Research area												
Cognition And Behaviour	63.2	51.9	49.3	60.3	57.6	51.2	44.8	53.8	60.2	53.4	42.9	66.7
Computational Neuroscience/Robotics	78.8	66.0	62.5	65.5	65.3	72.5	43.6	68.3	67.2	52.7	37.1	87.5
Disease Aetiology	62.5	64.3	70.0	67.6	55.6	74.5	59.0	79.7	74.1	65.0	59.4	58.8
Neural Function	38.9	40.0	37.0	36.6	38.3	50.4	50.0	58.6	58.0	53.0	34.7	56.1
Neuro-Immunology	80.0	71.4	50.0	40.0	64.3	58.8	64.3	73.5	50.0	60.9	16.1	44.4
Neuronal Development	40.6	32.3	42.1	30.3	52.6	64.9	51.6	77.8	57.6	39.3	45.5	60.0
Sensory And Motor Systems	71.1	55.8	39.7	46.4	50.6	47.1	47.2	63.2	62.5	48.0	35.1	68.2
Clinical Research	88.9	79.3	87.8	82.5	74.6	77.6	58.4	68.6	57.4	52.0	48.4	77.8
Health Care & Social Care	61.9	66.7	78.6	90.3	76.2	81.8	58.3	68.4	65.9	46.3	42.5	81.8
Public/Patient Engagement	88.9	85.7	57.1	64.3	62.5	75.0	36.8	63.2	60.0	50.0	46.5	33.3
Research Tool												
Animal Model	58.3	48.7	53.6	48.6	51.2	48.5	52.9	65.9	56.4	53.0	39.5	51.4
omics	53.2	50.0	57.4	48.7	44.2	50.6	42.6	68.7	58.1	47.9	42.6	65.0
Diagnostics & Neuroimaging	67.3	59.5	54.0	56.9	47.5	58.3	51.5	43.4	54.1	43.0	32.3	60.5
In Vitro Model	41.0	43.9	33.3	29.6	32.8	52.2	33.3	61.4	71.7	60.8	44.0	54.5
Therapy	86.1	74.2	70.7	63.1	64.7	63.8	56.1	62.7	56.2	51.9	51.1	66.7
Disease Area												
Neurodegenerative	71.9	70.3	51.1	51.4	46.4	64.8	57.1	66.2	62.1	46.8	40.8	57.1
Neurodevelopmental	50.0	60.0	66.7	50.0	59.1	50.0	47.8	57.7	56.5	52.6	43.5	80.0
Neurological	73.3	57.9	35.3	64.5	60.0	64.5	50.0	62.5	51.2	45.0	39.2	64.3
Neurosurgical	77.8	66.7	47.1	12.5	35.7	47.4	50.0	55.6	62.5	70.6	33.3	66.7
Psychiatric	69.2	50.0	57.7	60.7	47.1	75.0	46.9	45.8	53.6	40.0	47.1	66.7
Sleep-Awake	50.0	0.0	0.0	33.3	0.0	0.0	33.3	60.0	50.0	50.0	16.7	NA

ANNEX VII. Which brain research topics are related to smaller/larger consortia?

For each research topic we evaluated the distribution of the number of participants in the projects related to that topic. On average, brain researchers collaborated in 39% of all research projects and mostly when the projects address Public/patient engagement, health and social care and robotics. Less consortium participants are involved when the project focuses on neuronal development, neural function, and sleep-awake disorders[23]. In the Figure below, we see the percentage of projects involving 2 or more participants in the consortium. In the table, the percentage of projects is shown by consortium size and topic.



Percentage of projects involving 2 or more participants in the consortium

[23] Note that some calls (e.g., European Research Council) do not require a consortium but a single PI. The results should be interpreted as such.

Percentage of projects by consortium size and topic							
		Consortium size					
	n = 1	between 2 and 5	between 6 and 10	between 11 and 20	between 21 and 50	between 51 and 100	more than 100
Research area							
Cognition and Behaviour	74	15	6	4	1	0	0
Computational Neuroscience/robotics	59	15	15	8	2	0	0
Disease Aetiology	53	23	8	12	4	0	0
Neural Function	80	12	5	2	0	0	0
Sensory and Motor Systems	74	13	9	4	0	0	0
Robotics	40	20	28	12	0	0	0
Neuronal Development	77	12	6	4	0	0	0
Neuro-Immunology	63	17	7	9	4	0	0
Clinical Research	49	17	14	15	5	0	0
Health Care & Social Care	38	14	25	19	4	0	0
Public/Patient Engagement	34	17	18	22	8	0	1
Research tool							
Animal model	74	16	6	4	1	0	0
Therapy	52	20	13	12	3	0	0
Neuroimaging	74	15	5	5	2	0	0
omics	72	17	4	5	1	0	0
Diagnostics	50	13	12	18	6	0	0
In vitro model	70	17	8	4	1	0	0
Disease area							
Neurodegenerative diseases	52	18	15	12	3	0	0
Neurological diseases	57	17	12	12	2	0	0
Psychiatric diseases	55	20	10	10	4	0	0
Neurodevelopmental disorders	54	22	11	10	4	0	0
Neurosurgical diseases	61	22	8	8	1	0	0
Sleep-Awake disorders	82	15	3	0	0	0	0